Global Livestock CRSP
Annual Report 2005

Edited and Designed by Susan L. Johnson
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Management Entity, University of California, Davis,
258 Hunt Hall, Davis, California 95616
Telephone: (530) 752-1721. Fax: (530) 752-7523
Email: glcrsp@ucdavis.edu
Web Site: http://glcrsp.ucdavis.edu

Cover Photo: An elite flock of Kazakh Finewool Sheep owned by farmer Dulat Kegenbekov. The farm is located in the Almaty region in southeastern Kazakhstan. The flock is the result of many years of breeding and selection by Toleghen Kasenov, a scientist from the Sheep Breeding Institute in Kazakhstan. Mr. Kasenov worked with the sheep when they were owned by a Soviet state farm and continues to do selection now that the flock is privately owned. The photo was taken by Liba Brent.

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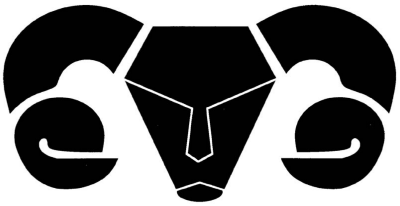


Preface

Each year, the Global Livestock Collaborative Research Support Program publishes an annual report in compliance with grant requirements. The 2005 Annual Report documents work completed during the fiscal year, October 2004 - September 2005. The principal investigators for each project submit reports on research conducted with GL-CRSP funding. Each report is the expression of the principal investigator with minor editing by the Management Entity. All individual reports give the name, address, telephone, fax number and email address of the principal investigator for that project. Inquiries are welcome.

Susan L. Johnson
Annual Report Coordinator

Foreword

Bridging Institutional Barriers to Make Horizontal Connections in a Vertical World

By Dr. Montague W. Demment
Director, Global Livestock CRSP

Agriculture, natural resource management (NRM) and development are intimately connected presently and historically. To be most effective in our development efforts we should maintain that connection in our institutions. Unfortunately universities and USAID are moving in the opposite direction. Two recent books by Jared Diamond deserve attention by the development community and have particular relevance for the organization of agriculture and NRM within our institutions. The first, "Guns, Germs and Steel: The Fates of Human Societies "(Pulitzer Prize Winner for Non-Fiction in 1998), explains the reasons for the differences in the advances of different societies, and what happened when formerly isolated groups came into contact. Diamond argues that it was the natural resource base, primarily the array of plants and animals available for domestication, the nature of the physical environment and the shape of continents that gave groups their advantage in the development of agriculture. Agriculture then led to increased population, hierarchical societies, division of labor and technological development: the guns and the steel. The germs were the evolution of the zionotic diseases that came with domestic animals. Agricultural populations became resistant through exposure over time but those groups without domestic animals were literally wiped out when they had contact with the agricultural populations.

The importance of "Guns, Germs and Steel", is not just to remind us of the fundamental role of agriculture in the development of societies and economies but

also to emphasize the interconnection between agriculture and environment. Diamond takes the position that all men are created equal in intelligence and creativity but endowed with very different natural environments. His thesis is that this intimate link between agriculture and the environment was critical to the trajectory of societies' development. If we can explain historical patterns of human societal and economic development by this linkage, should we not preserve the same connection in our development efforts?

In his most recent work, "Collapse: How Societies Choose to Fail or Succeed", Diamond tackles the complicated question of why some societies succeed and others fail. He analyzes in detail the failure of the Mayans, the Norse Greenlanders, the Anasazi and the Easter Islanders and the successes of the New Guinea highlanders, the Tikopia islanders, and the 16th and 17th century Japanese against a 5-point framework: environment, climate change, hostile or friendly neighbors, and societal response to problems that are often considered only environmental collapses. However Diamond, with his usual keen insight, draws on this more complicated array of elements from his framework, but one cannot help be impressed by the role of environmental management and agriculture as a fundamental relationship whose management is critical to the trajectories of these societies.

What is equally important in determining whether societies succeed or fail is their ability to deal with short-term problems in a way that ensures long-term solutions. Perhaps the clearest example that Diamond provides is the contrast between the Dominican Republic and Haiti. Both share the same island yet their development trajectories are markedly different. A number of elements may be involved, but Diamond emphasizes the importance of NRM policy differences between the two countries as the basis for reasonably successful economic growth and environmental management in the Dominican (albeit by two relatively totalitarian dictators in the Dominican) and the struggles of Haiti. These strong

men imposed policies that saved the environment, not for benevolent but selfish reasons, in the face of strong and pervasive short-term interests that would have destroyed the natural resource base, which is what happened in Haiti. A consistent theme in Diamond's analysis is the problem caused when short-term rewards encourage behavior and policies that ignore the long-term problems that eventually cause societies to fail.

I think both of these points made by Diamond have strong relevance in development. We should insure strong linkage between agriculture and the environment and we should ensure that development is not guided by short-term needs that may be convenient and politically adaptive but which run contrary to our long-term objectives. Historically agriculture and natural resource management, particularly conservation, have often been at loggerheads. With increasing populations the world is filling up. In this ever connected and full world what happens in one sector of the economy affects others and the landscape becomes a complex, web of interactive use and impacts. The problems of agriculture affect natural resources and conservation, and NRM has impacts on agriculture. These two sectors are inextricable linked. Coupled with the 'filling up' is the fact that much of the world's poor live in marginal environments that are highly susceptible to major perturbations such as the results of Hurricane Hugo. Poor people struggle day-to-day to meet life's requirements and their agriculture is increasingly forced to have a short-term horizon which conflicts with long-term NRM strategies. In our development work we are in a position to address this conflict but only if our agriculture and NRM strategies are coordinated.

Why, then, are they often separated within our institutions? Institutional structure is critical to effectively tackling problems and achieving objectives. At University of California, Davis strong arguments have been made to separate agriculture and environmental sciences, largely to insure that environment moves out of the shadow of agriculture and thrives on its own. At USAID agriculture and NRM are separated in different offices although housed under the EGAT umbrella. Institutional structure determines how funds flow and how funds flow determines rewards of promotion. In both the case of the universities and the Agency, the directionality of the vertical resource flows makes horizontal programs that cut across institutional boundaries difficult to succeed. I suggest that we need a major effort to develop mechanisms that coordinate agriculture and NMR to address the crosscutting issues that are critical to the success of development and have a major impact on the future of developing societies.

In a somewhat bottom up response to institutional challenges the GL-CRSP has, with strong support from the Office of Agriculture, been allowed to encompass both agricultural and NMR issues with its portfolio and often within its projects. The interface between livestock production, particularly extensive systems, and conservation and NMR issues is widespread and important. In east Africa for example, pastoralists historically used most of the arid and semi-arid lands for their livelihoods. The strong demands for meat regionally and globally are attracting focus on connecting pastoralists to markets and increasing the economic productivity of these rangelands. At the same time tourism revenues and biodiversity conservation concerns argue for protecting large portions of these lands. Our projects, such as PARIMA and LiTEK, deal directly with pastoral livelihoods, their markets and welfare to try to make the economies of these pastoral groups grow. POLEYC, now ending as a project, developed modeling tools to allow policy makers and managers to make better decisions on managing the livestock wildlife interface. Our Livestock Early Warning System (LEWS) has much potential for a satellite based system for managing the conservation areas and is yet unused by conservationists. Our new effort, YESEMA, links Yellowstone and Serengeti/Mara ecosystems, to allow an examination of problem solving approaches to managing national parks within a complex array of jurisdictions, peripheral uses and stakeholders. Land use has a direct impact on water quality and quantity. In SUMAWA we are building the capacity of a Kenyan coalition to do long-term research on watersheds and, through stakeholder involvement, solve watershed problems of a key tributary into Lake Nakuru National Park.

While the GL-CRSP is committed and pleased with this bottom up approach, we are also eager to participate in a more top down effort to integrate agriculture and NRM effectively within USAID. The challenge of successfully integrating our food production systems with our NRM efforts is one of the great challenges facing our world. Now that we are more globalized and connected, the world's future is much more a single entity like each of the societies that Diamond examines. In the end we will be the society of planet earth with a global environment and if our development efforts do not make a more equal world then no matter how rich the rich may be, we will all suffer the consequences together.

Program Overview

The Global Livestock CRSP has expanded its research to address important topics in the international livestock development sector. The program, comprised of broad-based interdisciplinary projects, focuses on human nutrition, economic growth, environment, and policy linked by a global theme of agriculture at risk in a changing environment. The projects involve researchers from 14 U.S. universities, 2 international agricultural research centers, 5 international research organizations, and 91 foreign institutions. The program is active in four regions of the world: West and East Africa, Central Asia, and Latin America.

History

Established in 1978 as the Small Ruminant CRSP, the Global Livestock CRSP is one of nine CRSP programs developed under Title XII of the International Development and Food Assistance Act of 1975. The CRSP model, pioneered by the SR-CRSP, was built on the structural strengths of U.S. land-grant universities and collaborative partnerships with international organizations. Four characteristics ensure the effectiveness of this model: 1) Collaboration with U.S. land-grant universities; 2) International training; 3) Long-term scientific relationships; and 4) Program cost-effectiveness.

Reengineered

In 1995, the CRSP began a major restructuring of the program in response to USAID's own reengineering efforts and the changing needs of the international development community. The process, a comprehensive planning and assessment procedure, was initiated with priority-setting workshops in the three regions. As forums for client input, the workshops were intended to maximize the opportunity of regional professionals to present their views on the development issues confronting them. The problem models they developed established the scope for activities within the region. Assessment teams, selected in an initial competition, developed projects that addressed the top priorities within the regions. The problem model was the central component of the assessment process. Each team was charged with refining its problem model through in-field explorations. To ensure grassroots input, over 20 regional workshops involving 35 countries were conducted during the assessment period. The teams submitted final proposals, competing to be in GL-CRSP's current grant, and winners were selected. The process was designed to be problem-driven and has produced results-oriented projects.

Program Goals

The goal of the GL-CRSP is to increase food security and improve the quality of life of people in developing countries while bringing an international focus to the research, teaching, and extension efforts of U.S. institutions. This goal is to be achieved through collaboration between U.S. universities and other institutions, and national and regional institutions abroad that are active in livestock research and development.

Strategic Objectives

To achieve this goal, the following objectives have been identified:

- Improve the interaction between livestock production and natural resource use and conservation, and more effectively integrate livestock production systems with the rational use of natural resources, such as wildlife and water.

- Decrease poverty and increase the security of people whose livelihoods depend on livestock by providing mechanisms to manage risk.

- Enhance the nutritional status - and decrease morbidity and mortality - of targeted populations, particularly children and women, through increased availability and utilization of animal source products, thereby increasing human capacity.

- Strengthen the ability of institutions in developing countries to identify problems in livestock production and develop appropriate solutions.

- Provide support to decision makers in developing policies that will promote: a) livestock production, marketing, and trade; b) human nutrition and child physical and cognitive development; and c) natural resource conservation and management.

- Develop and strengthen communication systems (including but not limited to extension) among livestock producers, policy makers, businesses, researchers, and consumers that promote greater market participation, increase human and institutional capacity, and improve policy.

Global Plan

The Global Livestock CRSP global program builds effectively on complementarities between projects in different regions. Centered on a theme of managing risk in our unpredictable world, the program is developing the capacity to predict risk so it can be better managed, improving the tools to cope with risk, and contributing to the mediation of risk. The GL-CRSP has chosen to work in ecosystems and regions where human populations and natural resources are most vulnerable, and in most cases, where biodiversity is most valuable. The GL-CRSP focuses on human nutrition, economic growth, environment and policy related to animal agriculture and linked by a global theme of managing risk in a changing environment.

Training Plan

The Global Plan recognizes human capacity building as a fundamental component of research and development. Training has always been a key component of the CRSP portfolio. The GL-CRSP design provides for a wide range of training possibilities and employs both traditional and innovative strategies to achieve its training goals.

Degree Training. The GL-CRSP provides funding for operational and research costs to both U.S. and host-country graduate students. Projects are encouraged to leverage funds to support tuition.

Non-Degree Training. Short-term training provides a cost effective means to build capacity. Training workshops and courses build capacity for not only students but host country professors, researchers and other development professionals.

The Jim Ellis Mentorship Program. Named in honor and memory of Dr. Jim Ellis, a renowned scientist, mentor and GL-CRSP principal investigator, these awards provide partial support to students in order to improve the overall quality of their research. The Program provides funds to conduct research in specialized facilities or field settings away from their home campuses and to provide opportunities for greater diversity in collecting and more creativity in analyzing data than would otherwise be possible. The awards are intended to provide supplemental funds for students already working on GL-CRSP projects.

Travel Grants for Students. To encourage student participation at the GL-CRSP conferences, a select number of travel grants are awarded to students for presentation of their findings at the conferences. The awards permit students to inform others about their research and bring them in contact with researchers from other disciplines and other projects.

Build Capacity of Institutional Partners. The GL-CRSP goal is to build both human and institutional capacity simultaneously within host-country partner institutions. Selective targeting of funds through project funding and program enhancement address key deficiencies within these partner institutions.

Characteristics of GL-CRSP Projects

The Global Livestock CRSP incorporates a broad and complex perspective on international development based on the following principles:

- Research should be demand-driven and problem-oriented, with considerable resources invested in problem assessment at the grass roots level.
- Impact should emphasize human outcomes, involvement of local communities, facilitation of research-extension links, and the building of partnerships with other stakeholders.
- Identification and communication of relevant policy issues should be a critical component of project planning and implementation.
- Integration of gender concerns and appropriate gender analysis should be an integral part of project research and results.

Global Livestock CRSP Projects

The Global Livestock CRSP program is not a static set of activities but a constantly evolving and dynamic array of problem-focused projects. The iterative process that developed the original core of projects in 1997 continues as new research findings guide the GL-CRSP portfolio. In addition to the core portfolio of projects, the GL-CRSP also funds assessment team projects and a limited number of small grant projects on topics of special interest.

Assessment Team Projects. Before a project begins its research program, it completes a short assessment phase, usually three to nine months. During this phase, teams are given modest resources to conduct in-country workshops, planning and assessment. This process allows the teams to refine the problem model iteratively, determine and adjust team composition to fit the evolving problem model and ensure that colleagues are compatible and the team is functional. These teams then produce a research proposal for a final competition.

Structure

The Global Livestock CRSP is administered as a grant to the University of California, Davis, which, as the Management Entity, administers subgrants to participating U.S. institutions and maintains fiscal responsibility.

The *GL-CRSP Program Director* is responsible for program development, coordinating activities of the projects across and within regions, and overseeing the daily operations of the GL-CRSP.

The *External Program Administrative Council* provides advice and guidance on the scientific management of the Global Livestock CRSP.

The *Technical Coordinating Committee* provides intellectual exchange and input on programmatic planning for the CRSP to the Program Director and the Program Administrative Council.

The *Pool for External Evaluation of Research* provides objective evaluations of the CRSP programmatic process on an as-needed basis.

GL-CRSP Organizational Structure

USAID Cognizant Technical Officer: Joyce Turk, EGAT/AG

Management Entity: University of California, Davis

Montague W. Demment, Program Director
Susan Johnson, Assistant Director
Cathy Miller, Budget Analyst
Gail Stroup, Program Coordinator
Quin Martin, Student Computer Resource Specialist
Corinna Cheung, Student Assistant
Marina Nasarova, Student Assistant
Suzanne Plant, Student Assistant

External Program Administrative Council

Deanna Behring, CHAIR, Pennsylvania State University
Gilles Bergeron, FANTA
Robin Mearns, World Bank
Salvador Fernandez-Rivera, International Livestock Research Institute
Dennis Poppi, University of Queensland
Ahmed Sidahmed, IFAD,

Lead Principal Investigators

Lindsay Allen, University of California, Davis
Layne Coppock, Utah State University (CHAIR, TCC)
Judith Ernst, Indiana University
Lisa Graumlich, Montana State University
Grace Marquis, University of Iowa
John McPeak, Syracuse University
Scott Miller, University of Wyoming
Robert Stobart, University of Wyoming
Jerry Stuth, Texas A&M University

Pool for External Evaluation of Research (PEER)

To Be Named

Livestock Information Network and Knowledge System (LINKS) for Enhanced Pastoral Livelihoods in East Africa

Narrative Summary

The urgency to address the needs of pastoral communities in eastern Africa has risen dramatically in the past few years, forcing national governments, NGOs, and international donors to explore high impact interventions for these neglected people. Given the high dependency of pastoral family livelihood on cash income from the sale of livestock and livestock products, institutional focus has been directed toward improving livestock market information, infrastructure and efficiency. A reliable market information system creates transparency and a basis for the pastoralists to make marketing decisions. An extensive review of the wide array of livestock market development activities in eastern Africa has revealed a lack of viable livestock market information systems to support decision making of traders, pastoralists and policy makers. Using a partnership approach with existing livestock marketing institutions in Ethiopia, Kenya, Somaliland, Djibouti, and Tanzania, the proposed research seeks to design and deliver an equitable livestock information and communication system that provides monitoring and analysis technology to foster strategic partnerships between pastoral communities, markets and policy. The LINKS program has established the necessary technical framework for the reporting of prices and volumes and help established a limited number of monitoring markets. This past year focused on building viable market information flow, stakeholder training and institutional strengthening for adopting the LINKS system in Kenya, Ethiopia and Tanzania. The LINKS program completed a spatial model of pastoral livestock movement in response to forage supply, terrain, water supply and ethnicity but there will be a focus on incorporating reporting of disease, market prices and conflict in the model in the coming year. With the framework established it will be possible to set the foundation to better understand the impact of the LINKS program on market efficiency to determine if marketing efficiency is improved and whether pastoralists are gaining a greater share of terminal market prices when they sell their animals. Impact of the LINKS technology package on agency effectiveness in information collection and dissemination on pastoral decision-making will also be assessed.

Research

Core Activity: Design and Deploy LINKS in East Africa

Problem Statement and Approach: During this past year primary activities were focused on refining the design and field testing of a unified approach to developing and deploying a livestock marketing information system (LMIS) within the framework of markets in Kenya, Ethiopia and Tanzania. Our specific objective was to design and deploy new communication and information technology to create a livestock information system (LINKS) to support decision making at multiple scales from policy makers to pastoral communities within livestock market chains of eastern Africa.

The core program involved a series of simultaneous activities focused on information technology development, establishing communications infrastructure and technology, identifying and developing working relationships and skills with key livestock marketing authorities/divisions/agencies and livestock trade organizations in Ethiopia and Kenya with some preliminary discussions in Tanzania, acquiring livestock market information to support need for market information and

modeling analysis as well as design of potential output products and delivery systems. Dr. Abdi Jama was assigned as primary liaison between LINKS/ TAMU and Ethiopia/Somaliland marketsheds. Dr. Robert Kaitho was assigned as primary liaison between LINKS/TAMU Kenya/N&C Tanzania marketsheds. Our three in-county program officers Mr. Abdirahman Ali based in Addis Abba, Ethiopia, Mr. Gatarwa Kariuki in Nairobi, Kenya and Ms. Margaret Kingamkono in Arusha, Tanzania provided liaison with key ministries, NGOs and pastoral communities in each country. Dr. Laban MacOpiyo joined the LINKS project in August 2005 as Postdoctoral Research Scientist. Dr. MacOpiyo will focus on the implementation of the new USAID Ethiopia Mission funded program on the expansion of LINKS in the Somali and Afar region.

Progress. The necessary partnering with Kenya, Ethiopia and Tanzania livestock marketing agencies has been established with agreements to work with the LINKS program to develop an integrated livestock marketing information system established in Ethiopia and Kenya.

In Ethiopia the LINKS market information system has been adopted as a basis for the implementation of a unified national market information system and a memorandum of understanding has been signed to that effect in September 2005. Consequently, the incorporation of a USAID Southern Tier funded livestock market information system being implemented by the Department of Livestock and Fisheries Marketing and LINKS at GLCRSP is underway. LINKS is currently re-training the monitors on the adopted market data collection format. A new high speed server is also being deployed by LINKS at the Department to accommodate data handling. The Livestock Market Information System webportal/ gateway for Ethiopia is currently hosted by LINKS TAMU. The Webportal is used for data handling both for entry and dissemination. The site now reports up-to-date weekly market transactions (prices and volumes) and provides basic and intermediate level analysis of market transaction trends for the markets being monitored. The biggest challenge is the low communication infrastructure. Alternative reporting tools, such as faxes, have been employed to report information on market data and to disseminate information in market places where Internet connectivity is limited or non-existent.

USAID is significantly expanding its interventions in the livestock sector in Ethiopia by launching a Pastoral Livelihood Initiative (PLI) with the goal of reducing poverty, hunger and vulnerability to droughts and other shocks in selected pastoralist communities in Ethiopia. The main objective of the PLI is to address the needs of increasingly vulnerable pastoral communities in the country due to climatic shocks, i.e. drought, and lack of access to markets through mitigation of these shocks by sustainable improvement of preparedness, livelihoods and incomes of pastoralists. This initiative will complement other USAID livestock programs in Ethiopia such as LINKS GLCRSP. The USAID livestock programs in Ethiopia are expected to support livestock trade policy, public/private partnerships, and lay the foundation for a long term positive change towards achieving food security, sustainable livelihoods and rural economic growth in Ethiopia.

The PLI grants were awarded mostly to Non-Governmental Organization in the country both national and international. Save the Children UK was awarded to lead one of the key programs regarding the establishment of livestock specific early warning and response mechanisms in Somali and Afar regions and select lowland woredas of southern Oromia region (approximately $3.3 million). LINKS GLCRSP and First Voice International are key partners in this program as sub-grantees. LINKS has long recognized the importance of interacting with the DPPC, DPPB, SCF-UK and FVI in Ethiopia in livestock early warning issues over the past couple of years. It was only due to the limited project resources and subsequent inadequate geographic coverage in the country that has hindered meaningful integration of the various early warning components being conducted by these institutions in Ethiopia. The partnerships and the funding from Pastoral Livelihood Initiative (PLI) Early Warning grant (PLI-EW) will bolster the efforts towards the development of a coherent and comprehensive national early warning system

that could help improve pastoral livelihood and protect the natural resource base in already fragile rangelands by implementing proactive interventions. This new funding secured by LINKS GLCRSP as a sub-grant from the PLI-EW grant led by Save the Children UK will allow for the expansion of the LINKS GLCRSP activities into more areas in the Somali and Afar regions of Ethiopia. PLI-EW partners will generate Early Warning reports, market prices, forage forecast images and other relevant Early Warning information, which will be uploaded to a new WorldSpace container for dissemination into the remote pastoral areas. Furthermore, LINKS GLCRSP has had significant discussions with the other recipients of the PLI grant recipients on livestock marketing such as ACDI/VOCA and the Sanitary and Phyto-sanitary project led by Texas A&M University on collaboration in the expansion of LINKS market monitoring activities in various parts of Ethiopia and in key Ethiopian Livestock export markets in the Middle East.

LINKS GLCRSP has concluded setting up a forage monitoring system in Djibouti and Somaliland funded by Chemonics as key component of an Early Warning program in the pastoral regions. These two countries are now added to the automated LINKS regional forage reporting web portal. LINKS project drafted a Memorandum of Understanding with the Ministry of Agriculture and Rural Development of the Republic of Djibouti on the institutionalization and implementation of LEWS in Djibouti. The project started dialogue with key agencies in Somaliland on institutionalization of the livestock early warning program and initiation of livestock market monitoring system.

LINKS GLCRSP has been engaged in a dialogue with the Pastoral Commissions and Rural Development Bureaus in the Regional States of Ethiopia to encourage their ownership of the livestock market monitoring programs in their respective areas. Memoranda of Understanding between the Regional Commissions and LINKS GLCRSP have been drafted to this effect and are currently being reviewed by the concerned parties. Tanzania is currently reviewing the agreements. Technical and in-country staff have been put in place and working relationships have been established.

Market codes, sampling standards, livestock kinds, breeds, classes and grade coding system have been developed with all stakeholders in each country (Figure 1). These agreements have led to development of a LINKS monitors training protocol which has been implemented via a series of training workshops. The coding system was implemented in centralized and regional satellite or internet-linked database and analysis systems.

We have successfully rewritten software (LINKS II) that improves management of the SMS text messaging system and provides greater market analysis for the user of the data. We trained and provided cell phones and scratch cards to livestock market monitors from collaborating institutions in livestock markets in Kenya (Nairobi, Garissa, Isiolo, Wajir, Marsabit, Moyale, Marigat, Emali and Mombasa) and Tanzania (Dar Es Salaam, Shinyanga, Moshi, Arusha, Iguga)

Figure 1. Animal kind, class, grade, breed and market codes developed for the SMS system.

ANIMAL KIND

Animal kind	Code
Cattle	C
Sheep	S
Goat	G
Camel	CA
Donkey	D
Mule	M
Horse	H

ANIMAL CLASS

Immature all	IA
Immature male	IM
Immature castrate	IC
Immature female	IF
Young all	YA
Young male	YM
Young castrate	YC
Young female	YF
Mature all	MA
Mature Male	MM
Mature castrate	MC
Mature female	MF

ANIMAL GRADE

Fat	1
Moderate	2
Thin	3
Emaciated	4

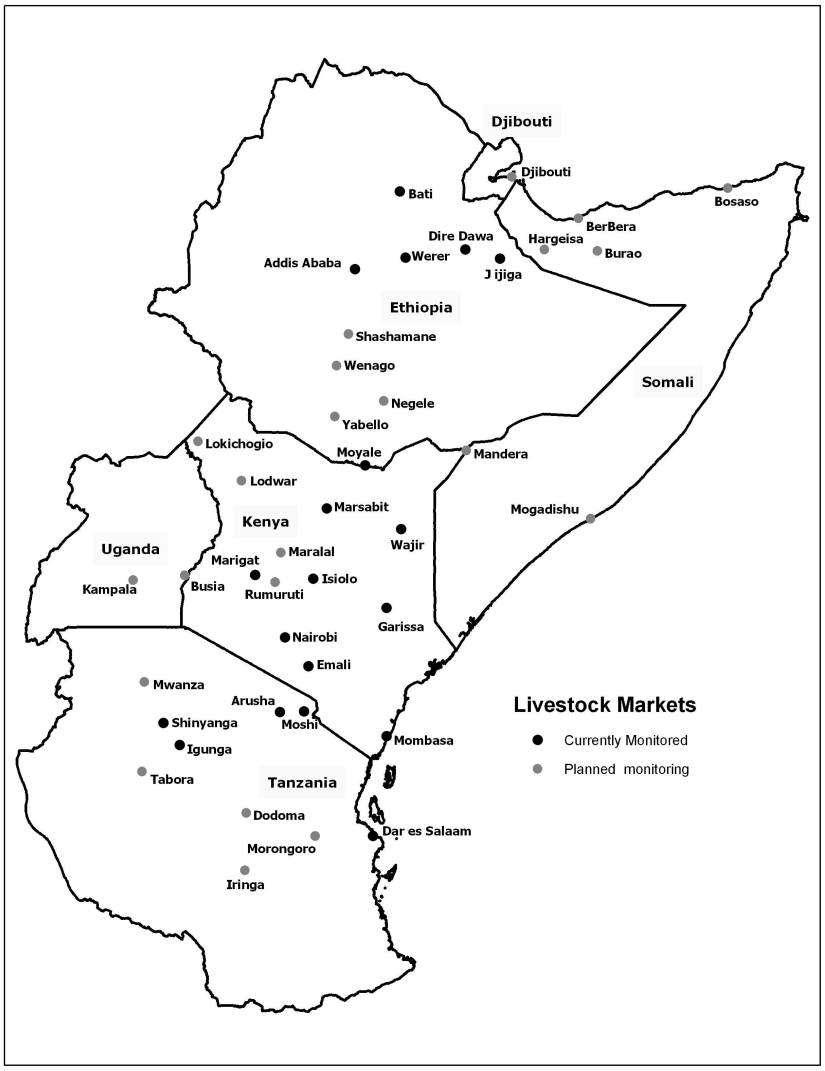
ANIMAL BREED CODES

ANIMAL	BREED	CODE
Cattle	Boran	B
Cattle	Zebu	Z
Cattle	Sahiwal	S
Cattle	Exotic	E
Cattle	Mixed	X
Goat	Galla	G
Goat	East Africa Dwarf	E
Goat	Mixed	X
Sheep	Black Head Persian	B
Sheep	Red Head Maasai	R
Sheep	Mixed	X
Donkey, horse, mule, camel	Mixed	X

MARKET CODES

Nairobi	NRB
Mombasa	MSA
Garissa	GAR
Wajir	WAJ
Moyale	MOY
Isiolo	ISI
Emali	EMA
Marsabit	MAR

Figure 2. Established livestock markets currently monitored and planned to be incorporated in the LINKS system.



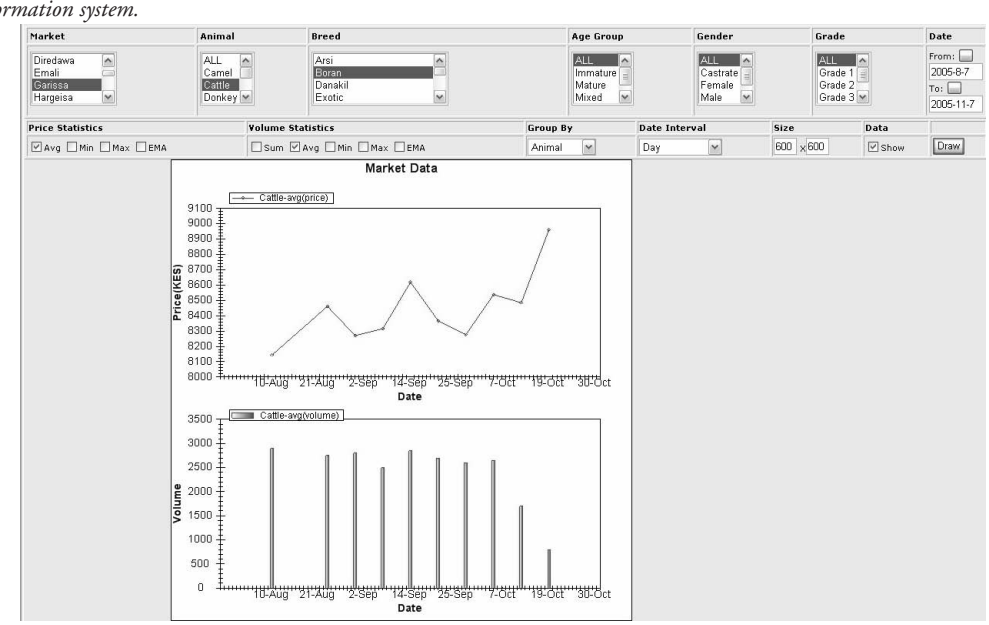
markets to implement the concept of receiving and transmitting price/volume information by animal type, breed, class and grade of livestock. A SMS text coding system (shorthand) was devised and revised based on monitor feedback for effective transmission given the limitations in the number of characters allowed in a single SMS text which is only 160. Email and Internet interfaces were also developed to enable web-based data entry and query.

The market monitors from Kenya and Tanzania were trained on how to construct and type in SMS messages in their cell phones. A complete SMS message needs to have the codes in a definite sequence for the SMS server to parse the SMS message and automatically put the data in the data base. The monitors are trained on various aspects of data collection and reporting including sampling at the market, grading, data recording and coding, sending and querying data through short message service and the internet.

We were able to establish active market reporting with SMS text messaging using cell phones in Kenya, Ethiopia and Tanzania (Figure 2). In the past year we were able to ensure a steady flow of timely, regular and reliable livestock market information to producers, traders and consumers in those markets we have set up. We were able to reduce the amount of field and deskwork required to produce livestock market information through automation of data collection, processing and dissemination using state-of-the-art ICT technology. We have also secured consensus and systematic adoption of our products by key government and NGO's institutions in the countries we have project activities. We have also secured complementary funding to cover extension of monitored market network and resources to cover training workshops. Moreover, the LINKS team were contracted to design a FAO web system (EXCELEX) to support livestock export in the Horn of Africa. LINKS provides the livestock market information to be displayed in the website.

An example of the data so far collected in the database is shown in Figure 3 below. Grade 2 cattle is fatter than grade 3. The data is also used to analyze trends in sales and prices, differential pricing at

Figure 3. Example of SMS reported prices of mature male and female Boran cattle for Garissa, Kenya derived from the LINK livestock market information system.



different markets, and sensitivity to price changes of different classes and grades of animals at the terminal markets.

Activity One: Decision Support System for Monitoring Livestock Markets and Movement

Problem Statement and Approach. In the prior 5 years, the primary thrust of our research in LEWS focused on development of a livestock early warning system with emphasis on drought and forage supply in pastoral regions of East Africa. However, interactions with pastoral communities has revealed the need to gain a more comprehensive understanding of the variety of factors affecting the decisions made by pastoralists in reaction to not only drought but to disease incidence, water supply, conflict and market conditions.

Most of our activities to date have focused on creation of an agent based, object oriented design spatial model of livestock movement and offtake for the Kenya/Southern Ethiopia marketshed. Specifically, our objective has been to expand the forecasting capacity of the LEWS component of LINKS via the development of a spatially based decision support tool to model livestock movement and market offtake given constraints of forage supply, water availability, disease incidence, environment-induced conflict risk and market prices.

Progress. ***PLMMO Mode*** An agent based-model of mobility of pastoralists was developed by a GLCRSP funded PhD student, Laban Macopiyo and applied to the semi-arid rangeland region extending from southern Ethiopia to northern Kenya. Dr. Macopiyo has now joined the LINKS/GLCRSP team to help manage a USAID Mission supported project that expands the marketing and early warning component of LINKS in Ethiopia. The model was used to investigate temporal adaptation of pastoralists to the spatial heterogeneity of their environment. The simulation model developed is called Pastoral Livestock Movement Model (PLMMO). PLMMO is a spatially explicit, individual-based pastoralists-animal foraging and movement model. Users can create or replicate heterogeneous landscape patterns, and place resources and individual pastoralists and their livestock on that landscape to simultaneously simulate the foraging and movement behavior of the pastoralists in a rangeland ecosystem. Pastoralists' herd mobility patterns and other measures of movement were compared to data from field studies. Predictions of the model correspond to observed mobility patterns across the seasons. The distances

moved were found to be significantly correlated (r2 = 0.927 to 0.977, p<0.0001) to the drought and non-drought climatic regimes. The PLMMO model therefore proved to be a useful model for simulating general movement patterns of pastoralists relative to movement range sizes in the pastoral rangelands of southern Ethiopia and northern Kenya. The PLMMO model was used to explore the impact of emerging patterns of rangeland use under pastoralism in the arid and semi-arid rangelands of Kenya and Ethiopia. The ways in which pastoralists' mobility patterns adapt to emerging challenges of livestock and population increase, reduction in land area under pastoralism, and the possible outcomes brought about by climate changes to grazing in these savanna rangelands were addressed using the Pastoral Livestock Movement and Model. Four types of scenarios were simulated and explored for how they impacted patterns of pastoralist of mobility. The scenarios explored were 1) climate change with concomitant reduction in forage yield, 2) climate change with concomitant improvement and higher variability in forage yield spread over the dry and wet seasons, 3) increased livestock population densities and 4) improved access to water. The climate induced change scenario with increased and more variable forage production resulted in the shortest distances moved by pastoralists in comparison to all the other scenarios. The total search distances under this scenario were only 20% of the normal season distances. The improved water access scenario also returned a significant (p=0.017) drop in distances moved. There was however, no significant impact on either increase in livestock numbers or reduction in available forage on mobility. We judged the agent-based model PLMMO developed here as a robust system for emulating pastoral mobility in the rangelands of eastern Africa and for exploring the consequences of climate change and adaptive management scenarios.

In order to further build upon this concept, we have partnered with EROS to submit a NASA grant ($ 1,050,000/ 3 yrs) to determine if the new ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) imagery could be useful in locating and predicting loss of key water supply ponds in the southern Ethiopia and northern Kenya region which are key to triggering large scale livestock movements. The pre-proposal was accepted by NASA and is in the second round of evaluation (25% of proposals funded in 2nd round).

We completed a MSc study at the University of Nairobi with Ms. Bridget Ochieng, titled "Assessing Market Integration in the Presence of Transaction Costs: Case of Pastoral Livestock Markets in Kenya". Ms. Ochieng has collected an extensive amount of price and volume data and interviewed traders for the Isiolo, Garissa and Nairobi livestock markets. The data show that a previous week change in a market price by one unit will lead to a decrease of 0.4 units of price (this week price) in a secondary market such as Isiolo. Likewise if the prices in a secondary market two weeks ago changed by 1 unit then this week's prices will decrease by 0.1 units. However, if last weeks prices in terminal market (Nairobi) change by 1 unit then this week's price in secondary market will decrease by 0.04 units and if the prices two weeks ago change by 1 unit then this weeks prices will decrease by 0.02. The results were consistent with documented price movement trends indicating that a change in price two weeks ago will have less effect on the current price and that is why price change one week ago will have a more significant effect than price change two weeks ago. Other results from co-integration also show us that both Nairobi cattle and goat prices can depend on each other.

An additional student was added to the project from the Agricultural Marketing Department at the University of Nairobi. Mr. Mathew Komen will be working on understanding how pastoral communities utilize LINKS livestock market information data in the Garissa region based on the pilot reporting system established there by local city government, ministry personnel, NGOs and private traders. A market bulletin board was established by local organizations to report the LINKS LMIS data.

Activity Two: Capacity Building/ Institutionalization of LINKS System within Partner Institutions

Problem Statement and Approach. Critical to implementation of a LMIS for the wide array

of stakeholders and support policy decision makers addressing pastoral issues is the need to institutionalize the LINKS system in mission critical organizations. Our specific objective for this module is to develop the capacity for private and public institutions to fully integrate information from the LINKS system as part of their routine decision making process.

Progress. LINKS GLCRSP continued to build capacity within key national institutions in the eastern Africa region. Concerted efforts were made to build technological and human capacity to support Information & Communication Technology (ICT) in the region and increasing training possibilities. Here are some of the milestones in this regard in the project host countries:

Ethiopia

- Trained 27 local district staff/market monitors on the LINKS data collection format and dissemination protocols.
- Made a presentation on LINKS GLCRSP activities in Ethiopia for the staff of the Somali Pastoral and Agro-Pastoral Research Institute on March 28, 2005.
- Made a presentation for the staff of Rural Development coordination office and bureau of Cooperative of the Somali Region on the potential use of LEWS/LINKS products as tool for regional decision making in the rural and environment development issues.
- LINKS staff attended Ethiopian Pastoralists Day (EPD) and exposed LINKS GLCRSP initiative to pastoral communities who gathered to celebrate the day.
- Held a sensitization workshop on implementation of a unified livestock market information system for Ethiopia at Nazaret on August 22-23, 2005 with 39 participants from a cross section of national institutions both from Federal and regional government agencies, donors and NGOs. Key presentations were made by LINKS Staff regarding the project experiences on the development of Livestock Market Information System in the eastern Africa region at the regional and at the country levels (Ethiopia) respectively. Issues dealing with harmonization and integration of the experiences of the LMFD/ MoARD and LINKS/GLCRSP as a basis for the development of a national livestock market information system for Ethiopia were also discussed in detail. The integration of LINKS/GLCRSP and USAID STI Livestock Market Information in Southern Ethiopia was officially launched with LINKS/GLCRSP format endorsed as a basis for a standard national Livestock Market Information System.
- Organized a study tour on livestock market information system to Kenya and Tanzania for 9 participants from Livestock and Fisheries Marketing Department of the Ministry of Agriculture and Rural Development, and their counterparts from Pastoral Commissions and Agricultural and Rural Development Bureaus of the regional states of Ethiopia. The funding of the tour was secured from the Southern Tier Program of the USAID Mission in Ethiopia. The main focus of this study tour was to expose key staff on the application of modern technologies for use on livestock market data collection, processing and dissemination in other parts of the Eastern Africa region. Specific interest was given on the public and private partnerships in the implementation of LMIS in Kenya. The period of study tour was September 4-18th 2005.

Kenya

The accomplishments made in capacity building in Kenya included:

- November 2004: Trained alternate monitors for Garissa and Isiolo markets.
- 17 January 2005: Conducted a training workshop in Isiolo for 24 representatives from Ministry of Livestock and Fisheries Development (MoLFD), Arid Lands Information Network (ALIN-EA), Kenya Livestock Marketing Council (KLMC), private consultants, traders, District Livestock Production Officers (DLPOs) and livestock market monitors from six sites in Kenya.

- 28 February 2005: LINKS participated and made a presentation at the livestock stakeholders' workshop in Nairobi. Over 70 participants representing 20 different institutions attended. The purpose of the meeting was to proposed formation of a livestock marketing information stakeholders' forum.
- 15 March 2005: LINKS participated in a livestock marketing stakeholders' meeting held in Nairobi. 11 different institutions were represented: MoLFD, LINKS, KLMC, VSF-Suisse, FAO, FarmAfrica, FHI, ActionAid, Terra Nuova, ALIN-EA, AMREF.
- Number of LMIS stakeholder institutions increased to over 15.
- National LMIS stakeholders' forum created, LINKS a member.
- National LMIS coordination committee representing 7 institutions nominated, LINKS became a member of the committee.
- Participated in the drafting of a proposal on developing an integrated national livestock marketing information system for Kenya.
- 16 March 2005: Held consultative meeting with the project director of EduVision to explore possibilities of adapting the use of handheld computers for disseminating information in remote areas of Kenya.
- 25 May 2005: Held a field day for traders, government, County Council and NGO staff at Garissa market. Over 500 information posters and flyers were distributed.
- 26 May 2005: Conducted a training workshop for 14 SMS and internet users at Garissa. Two women members of livestock traders groups participated.
- 15 June 2005: Brief for Kenya ICT Federation. The Kenya ICT Federation is interested in educating rural people on ICT and in transferring / translating technical and agricultural information using ICTs such as mobile phones, which are becoming increasingly important delivery mechanisms for Kenyan farmers and marketers.
- 6-7 June 2005: Conducted a training workshop supported by SNV/KLMC on the livestock marketing information system developed by GL CRSP LINKS in Nairobi for 19 participants; 2 from SNV (Netherlands Development Organization), 9 from MoLFD, and 8 from KLMC, 3 were women.
- June 2005: 3 markets added onto the monitoring network; Emali in southern Kenya (Kajiado district), Marigat in Rift Valley (Baringo district), and Mombasa and supported by KLMC.
- Increased frequency of reporting for Nairobi market using the KLMC supported monitors.
- Firmed up institutional linkages with: Ministry of Livestock and Fisheries Development (MoLFD), Kenya Livestock Marketing Council (KLMC), Regional Agricultural Trade Intelligence Network (RATIN), Kenya Agricultural Commodity Exchange (KACE), Kenya Livestock Traders Association (KLTA), Food for the Hungry International (FHI), SNV Netherlands Development Organization, Kenya ICT Federation, Arid Lands Information Network (ALIN), Radio and Internet (RANET), University of Nairobi.
- 22 August 2005: Participated in an informal consultative meeting on the GHA rural and pastoralist livelihood review at UNEP. The purpose of the meeting was to share ideas and discuss the types of data to be analyzed as part of the review. Participating agencies included UNEP, USGS/FEWSNET, UoN, ICPAC, RCMRD, LINKS/LEWS, WFP, FAO/FSAU.
- 25 August 2005: Participated in a technical meeting for the GHA pastoralist livelihood review at RCMRD. The agenda was to develop strategic planning for the implementation of the project on pastoral livelihoods review. LINKS was asked to prepare the part on socioeconomic analysis focusing on review of agricultural production trends and both human and livestock population trends.
- September 5-10: Hosted a team of 9 officers from different organizations in Ethiopia. The main objective of the tour was to enable the

participants to learn more about how available communication infrastructure can facilitate, simplify and open new opportunities for economic growth in Ethiopia. The tour was also aimed at demonstrating how public and private entities help each other in the process of acquiring and disseminating livestock market information and at acquainting participants on the challenges of rendering livestock market information services to stakeholders. The team visited LINKS office in Nairobi with presentations on LINKS/LEWS, AARNET, and VSF-Suisse, the MoLFD Department of Vet Services PACE programme, KACE, Garissa market, MoLFD marketing services division, KLMC, Dagoretti and Njiru markets and slaughter houses.

- September 2005: Hosted two managers with Tana and Athi Rivers Development Authority (TARDA) for a brief on LINKS/LEWS. TARDA expressed interest to collaborate on LEWS.
- 12-23 September 2005: Attended a workshop and training course on disaster reduction in Africa in Kampala Uganda.
- 22 September 205: LINKS participated in a meeting with FOODNET in Kampala, Uganda to explore opportunities for collaboration with LINKS on livestock marketing information reporting.
- 27-30 September 2005: Participated at the ADB/ASAL support to rural livelihoods project planning meeting in Mombasa. Made a presentation on LINKS/LEWS.

A major objective of LINKS is to integrate and promote the usage of information and communication technologies among various stakeholders in eastern Africa, by designing a hybrid cell phone/web-based livestock information delivery system that is responsive to the real needs of the users. Given this thrust, considerable effort was spent in this past 12 months to come to understand who the key players are in the region that would use and be impacted by our livestock market information system and ultimately provide them training in the use of the LINKS livestock market information system.

The project made significant progress in firming up linkages with the following institutions: Ministry of Livestock and Fisheries Development (MoLFD), Kenya Livestock Marketing Council (KLMC), Regional Agricultural Trade Intelligence Network (RATIN), Kenya Agricultural Commodity Exchange (KACE), Kenya Livestock Traders Association (KLTA), FHI, SNV, Kenya, Kenya ICT Federation, ALIN, Radio and Internet (RANET), and University of Nairobi. We made significant contributions toward developing a LMIS that is acceptable to a wide array of partners in Kenya. This has been through training of monitors and end users of the information, participating in livestock stakeholders meetings, presenting LINKS protocols at different forums, developing training and dissemination materials, and organizing demonstrations on the use of the short message service to send and query data. Over 61 representatives from Ministry of Livestock and Fisheries Development, Arid Lands Information Network, Kenya Livestock Marketing Council (KLMC), private consultants, traders, District Livestock Production Officers (DLPOs) and livestock market monitors from nine sites in Kenya have participated in these trainings. Three presentations have been made at local meetings of livestock stakeholders and collaborators involving over 70 participants representing 20 different institutions. As a result of this the livestock stakeholders forum advocated for the formation of a stakeholders forum to explore possibilities of developing an integrated national LMIS. Eleven different institutions are now represented at the LMIS stakeholders' forum. These include MoLFD, LINKS, KLMC, Veterinaires Sans Frontiers (VSF-Suisse), Food and Agriculture Organization (FAO), FarmAfrica, Food for the Hungry International (FHI), ActionAid Kenya, Terra Nuova Kenya, ALIN-EA, African Medical Research Foundation (AMREF) and others have been identified for invitation. A coordinating committee represented by 7 institutions has been nominated to spearhead the process of developing a proposal for an integrated LMIS and they have produced the first draft for review by the larger group. We held a field day demonstrating the use of the system to traders, government, county council and NGOs staff at Garissa market

where over 500 posters and information flyers were distributed. This was complemented with a training session of 14 users with access to the internet out of which 2 were women. The participation of women is significant given that in these societies there are cultural inhibitions that limit their participation in open market transactions, often considered the domain of men.

Gender

Transparency in livestock market information delivered through a variety of media including voice (radio, community speakers), print (notices, newspapers) to the population as a whole, regardless of gender and age, is one of the primary goal of this project. In doing so, both men and women, old and young can come to understand the information and jointly contribute to the decision making process within social norms of their respective clans, communities and families. LINKS activities, particularly in pastoral communities, have been organized to insure that participation of women are encouraged and when they attend they are actively involved in the discussion in a format that does not violate customs or traditions for discussing such issues. Verbal and print media reporting the LINKS LMIS information are placed in locations that are accessed by women as well as men.

The LINKS program has maintained and expanded the organizational network created under LEWS and retained leadership by the women that were so instrumental in maintaining the LEWS efforts in northern Tanzania, southern Kenya and northwestern Kenya. As we did in the LEWS program, we will seek out and encourage the role of women within the organizations we work with in a manner that makes sense for the organizations and for the functionality of LINKS.

We currently have four women in the LEWS program that will complete their degrees (3-MS, 1-Ph.D) and be finished up in the early months of the LINKS project.

To more specifically address gender, we have funded one graduate student in the Ag Marketing Department at the University of Nairobi to study the impact of LINKS market information on pastoral family decision making in the Garissa region of Kenya. The study will stratify decision making by family members and seek to understand potential impact on household income status.

Policy

Lack of information flow and equality of access to critical livestock market information and associated analysis on forage conditions, disease outbreak, conflict and water supply have all been listed as major strategic needs in the countries targeted for the LINKS program. All major national and international institutions have stressed that livestock market issues are of prime concern as they have a large impact on well-being of pastoral communities. Review of all the countries strategic plans indicate the need for a well defined livestock market information system that encompasses more than just market prices and addresses issues impacting market infrastructure and functionality such as drought (forage & water), disease, and conflict. Through work this past year, we have been able to have LINKS LMIS technology designated as the primary tool to manage LMIS obligations in the systems being set up in the Ethiopian Department of Livestock and Fisheries Marketing and the Kenya Livestock Marketing Services Division. This year we will focus on firming up the use of the technology and formalizing the technology within government policy for Kenya, Ethiopia and Tanzania. Members of the LINKS team have been designated as integral members of policy formation boards within these respective institutions. We have been provided office space and access to both these key organizations in the region to place our research technical people to work side by side with key decision makers in each institution to insure that LINKS addresses their needs for price and volume reporting systems. LINKS has and will continue to assist these agencies in addressing issues of information delivery, standardization of sampling for prices by kind and class of animals as well as identifying and pursuing critical research needs of these organizations. ASARECA has endorsed the LINKS concept as a major need within the context of the member Nation's strategic plans and is forming a regional grass roots effort to expand

the LEWS component embedded in the LINKS total information package. We are hopeful that it will be possible to advance more modern marketing structures in the future as we establish the tools and relationships within the program.

Outreach

Outreach activities have been reported under Activity Two, *Capacity Building/Institutionalization of LINKS System within Partner Institutions.*

Developmental Impact

The establishment of reliable and timely national and regional market information is viewed as vital for economic development by enabling producers, traders and policy makers make informed market decisions. Good communication and livestock information systems are also expected to reinforce commitments to productivity and to enhance the international competitiveness of the livestock industry in the region.

Environmental impact and relevance. The central thrust of the LINKS program is to provide a comprehensive livestock information systems focusing on markets, forage conditions, disease incidence, water supplies and conflict to prepare for adverse conditions in sufficient lead-time to allow government, NGOs and pastoral communities to react to the conditions in a timely manner to prevent resource degradation. Improved decision making in a timely manner leads to maintenance of critical plant cover and recycling of carbon back into the soil to maintain hydrological integrity of the ecosystem, resulting less soil loss and vegetation of higher ecological state.

Agricultural sustainability. Timely decision making by livestock owners concerning availability of forage supply, water, disease incidence, movement, conflict and marketing possibilities of livestock will be valuable for sustainable livestock production in east Africa. The indigenous knowledge of the pastoral societies regarding range and livestock will be much more effective if they can have access to near real-time information on forage forecasts and the marketing scenarios that minimize conflict throughout the year. A combination of the indigenous knowledge and modern science can be used by decision makers to formulate clear mitigation strategies to reduce risk from weather extremes. Recent technology breakthroughs in computer modeling, weather monitoring, animal nutrition profiling and communication infrastructures offer an unprecedented opportunity in accurately assessing impacts of emerging weather events on forage supply for livestock and wildlife and their ability to acquire nutrients to sustain themselves.

Contributions to U.S. agriculture. The techniques being pursued in the LINKS program, once stabilized, will have direct application in new emerging grazingland and livestock related monitoring needs for agricultural biosecurity in the USA. Dr. Stuth is a member of the Institute for Countermeasures Against Agricultural Bioterrorism (ICAB) at Texas A&M University and is Science Leader for Informatics in the new Dept. of Homeland Security Center of Excellence in Foreign Animal and Zoonotic Disease Defense for the Nation. He is also responsible for designing spatial modeling and near-real time analysis systems that involve monitoring of emerging forage and fire risk conditions by US Forest Service and USDA- Risk Management Agency and livestock diseases response strategies once incidences are detected. The lessons learned from LINKS will have a direct bearing on this suite of activities and we anticipate that tools and techniques will be directly transferred to these programs. We are anticipating that the new forecasting technology being pursued in LINKS will lead to a new concept being developed in USDA NRCS where the National Resource Inventory may move to a near-real time system if the techniques we develop are successful. The methodology for developing integrated communication and monitoring systems has application for a wide array of programs both in the USA and around the world.

Contributions to host country. Impact can be expressed in terms of (i) economic effects in terms of interventions on markets (labor, capital, goods, services) at multiple levels from households to national and transnational impacts, (ii) environmental impacts on biophysical and

ecological services of natural systems, (iii) social impacts on group composition, gender, disconnected populations, social capital within networks of associations and organizations at multiple levels, and structure/processes of local, regional and national governance, (iv) institutional impacts in terms of shifting behavior to other successful strategies, and organization, copycat activities and (v) policy impacts are reflected in compositional change of groups among lawmakers, or creation/change of law or regulations and improved effectiveness of disenfranchised lobbying efforts. The research team within LINKS will document impact at levels most appropriate for the technology deployed. We will establish baseline responses of major institutions and work with partner institutions to outline expected pathways to impact. Measurement instruments will be designed to establish if expected impacts did or did not occur and causal processes for impact, positive and negative. The intensity of impact assessment will be guided largely on funding levels provided to the project. However, we will focus primarily on measure of market efficiency as a measure of benefits to the host countries.

We do have the opportunity to conduct a sector level impact assessment. Our goal is to have an analytical framework in the Kenya Agricultural Sector Model with updated livestock sector secondary data to allow ex ante analysis reflecting different levels of adoption and the subsequent changes in marketing behavior of pastoralists, trades and exporters should the opportunity present itself.

We anticipate that the adoption of the LINKS LMIS technology in Ethiopia, Kenya and Tanzania will help them advance their plans for improving livestock market information and infrastructure development in each country. With our tools and training the respective institutions will be able to advance further and faster toward their stated strategic plans for livestock marketing in each country.

Linkages and networking. This year LINKS has continued to strengthen its linkages with the FEWS regional representative in east Africa and EROS FEWS NET. We are working closely with the USGS and country (Ethiopia, Kenya, Djibouti) FEWS NET representative, drawing our experiences together to address food security situations.

Lines of communication were opened with Food for the Hungry International (FHI), an NGO supporting livestock marketing component within their activities in northern Kenya. There is a livestock marketing information element with the system currently designed to operate using VHF radios at the market centres which are linked to a base radio in Nairobi. The poor ICT and transport infrastructure still remain big challenges, and it is in this sphere that the potential for partnering with LINKS was identified.

Various government agencies and trade organizations in Ethiopia were informed of the new standard livestock market information system both at the regional and federal levels. Most recently, the Somali Pastoral and Agropastoral Research Institute was brought into the data collection network in the Somali region. The Institute and their allied Research Centers are interested in the collaboration in the research and development of a unified system for the country and the entire region.

Collaboration with International Research Centers. LINKS has continued to collaborate with International Livestock Research Institute and its sub-programs such as ASARECA A-AARNET. Also, LINKS employed two national research scientists in Kenya and Ethiopia. These new scientists are housed at ILRI campuses in Nairobi and Addis Ababa. There are discussions currently going on between ILRI scientists and LINKS to explore more areas of collaboration. ILRI has just completed a reorganization of its program. ILRI has shown a strong interest in starting to work in the pastoral regions and is willing to tap on the experience of the GLCRSP in those areas.

Other Contributions

Support for Free Markets and Broad-Based Economic Growth. Development of a livestock marketing system and a comprehensive early warning system will allow a broader assessment of emerging conditions, create opportunities for livestock sales which will aid in the level of preparedness and mitigation of the effects of droughts. This reduced

drought risk will help promote the pastoral assets, which in turn can bring about local economic growth and purchasing power. It will also give the local governments opportunity to concentrate on development rather than relief. This is likely to result in increased trade and emergence of agricultural enterprises.

LINKS project aims to engage livestock trade associations, pastoral community organizations and policy makers in the development of a sustainable livestock market information system. It is expected that interactions between these groups will lead to the design of policies conducive to broad-based economic growth as part of a comprehensive poverty reduction strategy set out by the governments in the host countries as well as the United States Presidential Initiative to End Hunger in Africa (IEHA), which is the cornerstone of the agricultural strategy of the African Bureau of the United States Agency for International Development.

Contributions to and Compliance with Mission Objectives. Achievement of food security and improvement of the livelihood of the people in the Greater Horn of Africa by mitigating the effect of recurrent droughts and famine has been an important objective of the Greater Horn of Africa Initiative spearheaded by the USAID. It is anticipated that the development of a livestock marketing system in the region and an improved early warning system, will enhance responses of governments in the region and various donor agencies meet their food security and sustainable development objectives.

Concern for Individuals. The project is designed to secure working relationships with households, individual pastoralists, traders and middlemen. LINKS recognizes the fact that the pastoralists, whose livelihood depends on livestock, are the keys to the success of the project. To a large extent, the success of the project and sustainability will depend upon the participation and the commitment of the local people, traders and the ability of the project personnel to empower, motivate and involve them. Pastoralists' wealth is in their livestock, thus early warning information provided by LEWS component of LINKS could help ensure continued financial security for individuals and their families.

Support for Democracy. Freely available near, real-time and spatial market information and a livestock early warning system will improve the capacity of the peoples in east Africa to monitor and understand the dynamics of food security within their borders and throughout the region. Timely availability of this information will improve traditional coping mechanisms and avert conflicts. An improved knowledge network system, such as this, will also contribute to the creation of more stable and democratic societies where individual opportunity for prosperity and well-being is greatly enhanced. The provision of transparent information widely distributed to all components of society will provide a richer dialogue between stakeholders and empowering more segments to participate in resulting dialogue.

Humanitarian Assistance. The need for humanitarian assistance usually emanates from poverty-related degradation of natural resources. The comprehensive livestock information system that is being developed by LINKS is essential both for food security by protecting the natural resource base and for disaster preparedness. A proactive livestock information system will help in making people in the region less vulnerable to disasters by alerting them of impending crisis and provoking a humanitarian assistance response from local and international relief systems (e.g., governments, donor and NGOs). United States government, through USAID/OFDA, spends a lot of money on humanitarian crisis created by drought in east Africa.

Leveraged Funds and Linked Projects

Chemonics - 502978, LEWS for Dijbouti/ Somalilland, Funded to Jerry Stuth, 10/2004-9/2005, $149,500

Noble Foundation - 404170, LEWS for Central Oklahoma, Funded to Jerry Stuth, 6/2004-5/2005, $35,000

Dept Homeland Security - 503056, Resource Informatics for Defending Against Foreign Animal & Zoonotic Diseases, Funded to Jerry Stuth, 10/2004-9/2005, $524,662

USDA NRCS - 503093, Grazingland Spatial Analysis Tool, Funded to Jerry Stuth, 10/2004-

9/2005, $100,000

GMS, Inc - 503016, NDVI based forage loss insurance, Funded to Jerry Stuth, 10/2004-9/2005, $167,341

GMS, Inc - 503015, Rainfall based forage loss insurance, Funded to Jerry Stuth, 10/2004-9/2005, $155,384

Kelleher Professorship, Resource Informatics for Ranching, Funded to Jerry Stuth, 10/2004-9/2005, $12,000

Texas A&M University, Ann Zhang Stipend - Enhance Phygrow, Funded to Jerry Stuth, 10/2004-9/2005, $13,677

ILRI, VSAT Broadband Internet Support, Funded to Jerry Stuth, 10/2004-9/2005, $14,400

Training

Degree Training

Awuma, Kosi. Ghana, M, Texas A&M University, Range Science, Ph.D.

Byenkya, Stephen, Uganda, M, Texas A&M University, Animal Science, Ph.D.

Gibson, Zola, USA, F, Texas A&M University, Range Science, M.Sc

Kidane, Negusse, Eritrea, M, Texas A&M University, Range Science, Ph.D.

MacOpiyo, Laban, Kenya, M, Texas A&M University, Range Science, Ph.D.

Mnene, William, Kenya, M, University of Nairobi, Range Science, Ph.D.

Ochieng, Bridget, Kenya, F, University of Nairobi, Agricultural Economics, Msc

Omaria, Rose, Uganda, F, Makerere University, Veterinary Science, Ph.D.

Watta, Abdo, Ethiopia, M, Alemaya University, Agricultural Economics, Msc

Zander, Kristen, USA, F, Texas A&M University, Agricultural Development, M.Sc

Zhang, Ann, China, F, Texas A&M University, Range Science, Ph.D.

Non-Degree Training (Workshops, Field Tours)

Livestock Information and Knowledge System Tools Workshop. January 16 – 18, 2005 in Isiolo, Kenya. Facilitators: Robert Kaitho, Gatarwa Kariuki and Abdirahman Ali. Monitors and stakeholders training on LINKS tools, products and protocols. Attended by 24 participants (23 male, 1 female).

Livestock Information and Knowledge System Tools Workshop. June 6-7, 2005 in Nairobi, Kenya. Facilitators: Robert Kaitho, Gatarwa Kariuki. Collaborators training on LINKS tools, products and protocols. Attended by 19 participants (16 male and 3 female).

Livestock Information and Knowledge System Tools Field Training. January 20- February 8, 2005 in Dar Es Salaam, Iguga, Shunyanga, Moshi. Facilitator: Robert Kaitho. Collaborators and field monitors training on LINKS tools, products and protocols. Attended by 14 participants (10 male and 4 female).

Livestock Information and Knowledge System Tools Workshop. May 26, 2005 in Garissa. Facilitator: Gatarwa Kariuki. Collaborators and field monitors training on LINKS tools, products and protocols. Attended by 17 participants (15 male and 2 female).

Livestock Market Data Collection Format Workshop. August 18-19, 2004 in Bati, Ethiopia. Facilitators: Abdirahman Ali and Dubale Adamasu. To train market monitors on Livestock market data collection format developed by LINKS. Attended by 3 participants (2 male and 1 female).

Livestock Market Data Collection Format Workshop. September 16-19, 2004 in Jijiga & Dire Dawa, Ethiopia. Facilitators: Abdirahman Ali, Ahmed Yasin Bashir Dol. To train market monitors on Livestock market data collection format developed by LINKS. Attended by 4 participants (4 male and 0 female).

Livestock price reporting protocols, the use of E-mail and SMS Workshop. January 29, 2005 in Dire Dawa. Facilitator: Abdirahman Ali. To train market monitors on Livestock market data collection through e-mail and SMS. Attended by 2 participants (2 male and 0 female).

Livestock price reporting protocols, the use of E-mail and SMS Workshop. 28 March-5 April, 2005 in Werer, Dire Dawa, Jijiga, Samara and Bati. Facilitator: Abdirahman Ali. To train market monitors on Livestock market data collection through e-mail and SMS. Attended by 14 participants (14 male and 0 female).

Webpage management and livestock price reporting protocols Workshop. May 16, 2005 in Addis Ababa. Facilitators: Abdi Jama, Abdirahman Ali. To train EXCELEX IT team on Webpage management and LINKS market data collection through e-mail and on-line reporting. Attended by 4 participants (3 male and 1 female).

Collaborating Personnel

Ethiopia

Abdillahi, Bashir, Pastoral Commission, Somali Region

Adamasu, Dubale, FarmAfrica, Field Coordinator

Ali, Abdirahman, LINKS-GLCRSP, LINKS Research Assistant

Eshetu, Jemberu, Livestock Marketing Authority, BS, Team Leader, Market Res. and Follow-up

Gheddi, Ali, Safe the Children-UK, Field Coordinator

Haile, Getachew, Oromia Agricultural Research Institute, Research Officer

Hurrissa, Belachew , Livestock Marketing Authority, Head of Market Research and Promotion

Kebede, Dereje, FarmAfrica, Planning and Project manager

Teka, Habtamu, Oromiya Pastoral Development Commission.

Kenya

Abbas, Mohammed, Kenya Livestock Marketing Council, Executive Director

Golicha, Peter, Ministry of Livestock and Fisheries Development, Livestock production and marketing officer

Kariuki, Anthony , LINKS-GLCRSP, MA, LINKS Research Assistant, Ethiopia

Kirimi, Stanley, Ministry of Livestock and Fisheries Development, Livestock production and marketing officer

Maina, Joseph, Ministry of Livestock and Fisheries Development, Livestock Production

Marete, Francis, Ministry of Livestock and Fisheries Development, Deputy Director

Mbogo, Njunguna, Ministry of Livestock and Fisheries Development, Livestock production and marketing officer

Mbuvi, Dominic, Ministry of Livestock and Fisheries Development, Livestock production and marketing officer

Mohamed, Suleiman, Safe the Children-UK, Project Coordinator

Molu, Sora, Ministry of Livestock and Fisheries Development, Livestock production and marketing officer

Muggi, Daniel, Ministry of Livestock and Fisheries Development, Provincial Livestock Marketing Officer

Muli, Stanley, Ministry of Livestock and Fisheries Development, Provincial Livestock Marketing Officer

Ndumia, Margaret, Ministry of Livestock and Fisheries Development, Provincial Livestock Marketing Officer

Nthimba, Francis, Ministry of Livestock and Fisheries Development, Field assistant

Nyagweta, Ann, Ministry of Livestock and Fisheries Development, Field assistant

Nyambu, Habert, Ministry of Livestock and Fisheries Development, Livestock production and marketing officer

Ochieng, Bridget, University of Nairobi / Tegemeo Institute, Livestock production and marketing officer

Okuta, Paul, Ministry of Livestock and Fisheries Development, Field assistant

Ongori, John, Ministry of Livestock and Fisheries Development, Livestock Production.

Osman, Noor, Ministry of Livestock and Fisheries Development, Livestock production and marketing officer

Wafula, Bernard, Ministry of Livestock and Fisheries Development, Livestock production and marketing officer

Tanzania

Kingamkono, Margaret, Selian Agricultural Research Institute, Research Officer

United States

Jama, Abdi, Texas A&M University, Assistant Research Scientist
Kaitho, Robert, Texas A&M University, Assistant Research Scientist
Stuth, Jerry, Lead Principal Investigator, Texas A&M University, Professor

Collaborating Institutions

Ethiopia

Ministry of Agriculture and Rural Development
Livestock and Fish Marketing Department
Addis Ababa, Ethiopia.
P.O. Box 62347
Phone: +251-15502481

Oromia Pastoral Development Commission
Addis Ababa (Oromia Region), Ethiopia
Phone: +251-11233628, +251-11-229162
Fax: +251-11-1229166/7

Save the Children – UK
Addis Ababa, Ethiopia
P.O Box 7165,
Phone: +251-1-16293469/8
Fax: +251 -1-16293470
Email: scukethiopia@scfuk.org.uk

Disaster Prevention and Preparedness and Food Security Bureau/SC-UK Early Warning and Food Security Project Coordinator
Jijiga (Somali Region), Ethiopia
Phone: +251-25-7755866;
+251-25-7753012/13

Disaster Prevention and Preparedness and Food Security Bureau
Samara (Afar Region), Ethiopia
Phone: +251-33-6660060

Afar Regional State
Regional Vice President
Samara, Ethiopia
Mobile: +251-91-1173839
Save the Children – UK Jijiga office
Jijiga (Somali Region), Ethiopia
Phone: +251-25-7752775
P.O. Box 203 Jijiga
E-mail: ewprojectscuk@ethionet.et

Moyale District,
Somali Region, Ethiopia
Livestock, Crops and Natural Resources Development Office
P.O. Box 114
Moyale, Ethiopia
Phone: +251-46-4441055

Farm Africa
Addis Ababa, Ethiopia
Phone: +2511573288
Mobile: +251-911-226532
E-mail: farm.ethiopia@ethionet.et

Afar Pastoral Development Coordination, Farm Africa
Semera (Afar Region), Ethiopia
Phone: +251(033) 6660293/660292
+251-03-660262/63/060
E-mail: farmafar@telecom.net.et)

Werer Agricultural Research Center,
Werer (Afar Region), Ethiopia
Phone: +251-22-1140272 or +251-22-1140273 or +251-22-1140279
Mobile +251-911-828750
E-mail: warc@telecom.net.et

Bati Agricultural and Rural Development Office
Bati (Amhara Region), Ethiopia
Phone: +251-033-5530024/530086.
Fax: +251-033-5530016

Alemaya University
Department of Agricultural Economics
Alemaya (Harar Region), Ethiopia
P. O. Box 196, Alemaya, Ethiopia
Phone: +251-251-25-6610704
Fax: +251-251-25-6610713/19

Ethiopian Telecommunication Corporation
Customer Service Division
Addis Ababa, Ethiopia
Phone: +251-11 -5536104

FAO/Afar Livestock Recovery Project
Awash (Afar Region), Ethiopia
Phone: +251-22-2240705

Disaster Prevention and Preparedness Commission
Addis Ababa, Ethiopia
Phone: +251-11-5513011

Somali Region Pastoral and Agro-pastoral Research Institute
Jijiga (Somali Region), Ethiopia
Phone: +251-25-7753123
Fax: 025-7753122

Somali Region Rural Development Coordination Office
Jijiga (Somali Region), Ethiopia
Mobile: +251-91-5-330222
Fax +251-25-7753642

Jijiga Pastoral Agro-pastoral Research Center
Jijiga (Somali Region), Ethiopia
Phone: 025-7755053 or 025-7753122

USAID -Southern Tier Initiatives (STI)
Addis Ababa, Ethiopia
Pedro J. Carrillo, STI manager
Tel: +251-11-5510088, 510713
Fax: +251-11-5510043
E-mail: pecarrillo@usaid.org

Pastoralist Forum Ethiopia,
Addis Ababa, Ethiopia
Tel: +251-1-169487
Mobile: +251-91-604843
Fax: +251-1-169488
Email: pastoralistforumeth@ethionet.et

Dire Dawa Rural Development Coordination Bureau
Dire Dawa, Ethiopia
Tele: +251-25-1111306
Mobile Phone: +251-91-5734930
E-mail: oumerh2004@yahoo.com

Dire Dawa Disaster Preparedness and Food Security (DPFS)
Dire Dawa, Ethiopia
Phone +251-25-110220

Dire Dawa Agriculture office
Dire Dawa, Ethiopia
Tele: +251-25-1110460
Fax: +251-25-1110537

FEWS-NET Ethiopia,
Addis Ababa, Ethiopia
Tele.: +251-1-620218/16
Mobile: +251-9-220459
Email: alemu@fews.net

Ethiopian Telecommunication Agency
Legal Service
Addis Ababa, Ethiopia
Phone: +251 -11 -4652442
Fax: +251-11-465-5763

Ethiopian Information and Communication Technology Development Authority ICT Assisted Development (ICTAD) project
Addis Ababa, Ethiopia
Tel: +251-11-5520618

ACDI-VOCA-Ethiopia
Gabon Road,
P.O. Box 548 Code 1110 Addis Ababa, Ethiopia
Phone: +251-1-155-346-50; +251-1-155-346-51
Fax: +251-11-551-57-28

Kenya

FARM Africa
Northern Kenya Pastoralist Capacity Building Project
P.O. Box 49502-00100
Nairobi, Kenya
Tel: 254-20-2731664
Fax: 254-20-2732086
E-mail: info@farm-africa.org

Kenya Livestock Marketing Council
P.O. Box 2696-00200
Nairobi, Kenya
Tel: 254-20-317182
Fax: 254-20-317182
E-mail: klmc@livestockcouncil.org

Ministry of Livestock and Fisheries Development
Hill Plaza Building
P.O. Box 34188
Nairobi, Kenya
Phone: 254-20-2720306
Fax: 254-20-2728609
E-mail: dlp@africaonline.co.ke

University of Nairobi
College of Agriculture and Veterinary Sciences (Kabete Campus)
P.O. Box 29053
Nairobi, Kenya
Phone: 254-20-632211

Food and Agriculture Organization
Support to Emergency Preparedness and Response Project
KICC Building
P.O. Box 30470-00100
Nairobi, Kenya
Tel: 254-20-227496
Fax: 254-20-227982

Arid Lands Resource Management Project
Kenyatta International Conference Centre
P.O. 30510
Nairobi, Kenya.
Tel: 254-20-227168
Fax: 254 20-227982
Email: alrmphq@africaonline.co.ke

Regional Agricultural Trade Expansion Support Program
Wetlands Office Park, Waiyaki Way
P.O. Box 1555-00600
Sarit Center
Nairobi, Kenya
Tel: 254-20-4212000
Fax: 254-20-4212271

FEWSNET
Off Nyeri Road, Kileleshwa
P.O. Box 66613
Nairobi, Kenya
Tel: 3861475/76/79
Fax: 3861480

Netherlands Development Organization (SNV)
P.O. Box 30776
Nairobi, Kenya
Tel: 254-20-3870960/8
Fax: 254-20-3872491
E-mail: snvkenya@africaonline.co.ke

Regional Center for Mapping of Resources for Development
P.O. Box 632-00618
Nairobi, Kenya
Tel: 254-20-860227
Fax: 254-20-861673
E-mail: rcmrd@rcmrd.org

Terra Nuova
P.O. Box 74916
Nairobi, Kenya
Tel: 254-20-4445511/2
Fax: 254-20-4443748
E-mail: tnea@africaonline.co.ke

Arid Lands Information Network (ALIN)
P.O. Box 10098-00100
Nairobi, Kenya
Tel: 254-20-2731557
Fax: 254-20-2710083
E-mail: info@alin.or.ke

Food for the Hungry International
Northern Kenya Project
P.O. Box 125
Marsabit, Kenya
Tel: 254-69-2467
Fax: 254-69-2003
E-mail: mbtfhi@fhi.net

Publications

Jama, A.A., D. Tolleson, J.W. Stuth, A. Ebro, K. Zander and R. Kaitho. 2005. A decision support system for monitoring livestock diet quality and performance: verification study on cattle, Adami Tulu, Ethiopia. XX International Grassland Congress, Dublin Ireland. Offered Papers. Pp. 929-930.. Eds: F.P. O'Mara, R.J. Wilkins, L.'t Mannetje, D.K. Lovett, P.A.M. Rogers and T.M. Boland. Wageningen Agricultural Publishers.

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Lead Principal Investigator

Jerry Stuth, Kelleher Professor, Department of Rangeland Ecology and Management, Texas A&M University, College Station, TX 77843-2126. Tel: (979) 845-5548; Fax: (979) 845-6430. Email: jwstuth@cnrit.tamu.edu.

Livestock Trade in Kenya and Ethiopia (LITEK)

Narrative Summary

Livestock marketing is critical to development of arid and semi-arid lands in Kenya and Ethiopia. Donors are showing renewed interest in funding livestock marketing activities. Livestock market improvement offers the potential to reduce poverty in areas that are identified as the poorest in these countries. Such activities also allow donors to move from a "relief" mode to a "development" mode in dryland areas, as there is growing frustration with dryland activities being in permanent "relief" mode. However, the research community is not currently able to provide donors with clear and specific information to use in designing livestock marketing activities. It is not at all clear how research findings at the macro, meso, and micro levels are to be reconciled and used in program design. It is also not clear how markets should be designed to meet marketing needs in both "normal" and "crisis" periods.

What is missing is an overall sense of how interventions at different levels of the economy and under what prevailing conditions fit together spatially and over time, how they should be prioritized, and how they should be sequenced. While changes at all levels are needed, where should we start? How will changes at one level influence changes at a different level? Are any types of interventions pre-conditions for success of other interventions? Most specifically, can we be sure that changes in the market structure at higher levels will lead to poverty reduction at the household level? Can we be sure that potential benefits to changed market conditions at the local level will not be unobtainable due to blockages at higher levels? Can we identify policies at the international level that will encourage trade, or are currently inhibiting trade? Can we be sure that market interventions designed for normal times are flexible enough to address needs in crisis periods? The goal of this project is to begin developing an understanding of livestock marketing in Kenya and Ethiopia. The outcome will be the publication of these various insights, and the provision of a set of recommendations to donors interested in livestock market development.

Previous project efforts involved holding a priority setting workshop in Nairobi in August 2003. The proceedings of the August 11-13, 2003 workshop held in Nairobi are available at: http://faculty.maxwell.syr.edu/jomcpeak/marketworkshoppage.htm. Project efforts last fiscal year focused on selecting and funding six targeted studies that investigated livestock marketing issues in Kenya and Ethiopia based on the outcome of the deliberations at the workshop as noted in the 2004 annual report. Efforts were also made to approach researchers who are involved in market research in this area and funded by other projects to invite them to contribute a chapter to an edited volume.

Over the course of the current fiscal year, twelve chapters (six funded, six contributed) have been reviewed, revised, edited, and formatted by the editors John McPeak and Peter Little. Chapters went through at least two rounds of revisions in response to comments by the editors. An introduction was written by McPeak and Little, and a conclusion by McPeak, Little, and Demment was also completed for a total of 14 chapters (see Research section below). Over the course of the spring and summer of 2005, we initiated discussion with ITDG publishing concerning this book and negotiated terms for the publication of the volume. In the summer we were informed that ITDG publishing was interested in publishing, and was willing to commit to this pending peer review of the volume. We anticipated delivery of this volume to the publisher by the end of the fiscal year on September 30, 2005 in the work plan and in our negotiations with ITDG. Given

some inevitable delays in assembling the contents, this deadline was not possible to meet with the final version. However, the final version was sent to the publisher on November 1st, 2005 and is currently in the hands of the publisher undergoing production.

Research

The material in this section is drawn for the contents of the submitted manuscript. The title of the book is: Livestock Marketing in Eastern Africa: Research and Policy Challenges, by John G. McPeak and Peter D. Little (editors). The book will be published by ITDG Publishing. Anticipated publication date is April 2006, estimated length is 250+ pages, and estimated list price is US $ 29.95.

The chapter titles and their authors are as follows:

Chapter 1: Introduction, by Peter D. Little and John G. McPeak.

Chapter 2: Household-level Livestock Marketing Behavior Among Northern Kenyan and Southern Ethiopian Pastoralists, by Christopher B. Barrett, Marc F. Bellemare, and Sharon M. Osterloh.

Chapter 3: Livestock Marketing in Marsabit District, Kenya, over the Past Fifty Years, by John G. McPeak.

Chapter 4: Determinants of Market Prices of Livestock: The Case of Cattle in Alemaya, Eastern Ethiopia, by Teressa Adugna.

Chapter 5: Livestock Market Organization and Price Distributions in Northern Kenya, by Alan M. Green, Christopher B. Barrett, Winnie K. Luseno, and John G. McPeak.

Chapter 6: Determinants of Cattle Prices in Southern Kenya: Implications for Breed Conservation and Pastoral Marketing Strategies, by Maren Radeny, Patti Kristjanson, Eric Ruto, Riccardo Scarpa, and Jacob Wakhungu

Chapter 7: Linking Pastoralists and Exporters in a Livestock Marketing Chain: Recent Experiences from Ethiopia, by Solomon Desta, Getachew Gebru, Seyoum Tezera, and D. Layne Coppock.

Chapter 8: Innovations in Pastoral Livestock Marketing: The Emergence and the Role of 'Somali Cattle Traders-cum-ranchers' in Kenya, by Hussein A. Mahmoud.

Chapter 9: The Geography of Integration: Cross-border Livestock Trade in East Africa, by Fred Zaal, Morgan Ole Siloma, Rachel Andiema, Albino Kotomei.

Chapter 10: Working Across Borders: Methodological and Policy Challenges of Cross-border Livestock Trade in the Horn of Africa, by Peter D. Little.

Chapter 11: A Review of Policies and their Impact on Livestock Trade in Ethiopia During Three Regimes (1965-2005), by Yacob Aklilu.

Chapter 12: Livestock Market Information Systems for East Africa: The Case of LINKS/GL-CRSP, by Jerry Stuth, Abdi Jama, Robert Kaitho, Jimmy Wu, Abdirahman Ali, Gatarwa Kariuki, Margaret Kingamkono.

Chapter 13: Pastoralist Coping Strategies and Emergency Livestock Market Intervention, by John Morton.

Chapter 14: Policy Implications and Future Research Directions, by John G. McPeak, Peter D. Little, and Montague W. Demment.

Biographic and contact information about contributors is listed below in Personnel section of this report.

The following description of the contributions is drawn from chapter one of the volume.

The ordering of the chapters follows a conceptual division: we move from the household level, to the market level, to the issues of connections between markets, to national policy implications. The final two contributed chapters place specific emphasis on key interventions that are currently being formulated at the program level that could be scaled up to the national or even international policy level.

Chapters one and two mainly address household/micro-level dimensions of marketing. Chapter 2 by Barrett et al is based on data collected by the Pastoral Risk Management (PARIMA) Project of the GL-CRSP in Kenya and Ethiopia from 2000 to 2002. This chapter asks fundamental questions about what constrains households from selling more

animals. Analysis of this household level data is used to assess various hypotheses as to what kinds of investments should be made in arid and semi arid lands to improve livestock marketing systems. Critically, they find pastoralists are indeed quite active participants in livestock markets, and argue that many of the hypothesized constraints to pastoral involvement in markets are not supported by the evidence. They suggest that helping pastoralists build and keep herds by supporting viable pastoral production, improvements in institutional and physical infrastructure, and modifications to market institutions offer the most promise for stimulating livestock marketing and improving pastoralists' well being.

McPeak's Chapter (3) investigates long term changes in marketing behavior in Marsabit District, Kenya. Given the 'boom and bust' cycles in livestock populations, he argues it is important to develop a long-term understanding of marketing behavior to reveal what, if any, long term changes are occurring that may be masked by more volatile changes induced by livestock population dynamics. He reports the overall level of sales from the district and the livestock: grain terms of exchange do not appear to exhibit any long term trend. However, household level evidence suggests that sales rates have increased since the late 1960s. The data suggest herders sell more at a given herd size, but this impact has been offset by an overall decline in herd sizes. The findings indicate that: marketing policy needs to be designed both with short term fluctuations in mind and with long term objectives; there is little justification for increasing marketing in order to reduce aggregate herd size in this area; there is little evidence that existing alternative investments are more attractive than livestock keeping; and the goal of increasing revenue per animal sold rather than simply increasing the number of animals sold should be the objective of improving livestock marketing.

Three studies of price formation in livestock markets are contained in the volume. Adugna's chapter (4) is a study of price formation in a cattle market in eastern Ethiopia. He focuses on changes in the price per kilogram liveweight of animals rather than price per head. He presents evidence indicating that animal condition, age, and weight play significant roles in determining price per kilogram. In addition, the reason for purchase and the characteristics of the seller influence price. Finally, he notes that time of day and time of year influence the price that producers obtain for their animals. These findings provide a set of information that can be extended to producers to allow them to improve their production and marketing strategies to increase the benefits they obtain from marketing their animals.

Green et al in Chapter 5 investigate price formation in four northern Kenyan livestock markets for cattle, goats, and sheep. They find that both the mean price and price variance are influenced by animal characteristics, seller and buyer characteristics, seasonality, and market characteristics. They focus most analysis on the role of market characteristics, as these are most amenable to policy intervention. They present evidence indicating that introducing auctions is an effective way to increase pastoralists' income, as is improving market competitiveness by reducing transport bottlenecks. They find there is no evidence to suggest that market fees, availability of veterinary inputs or services, or availability of feeds increases market prices.

Radeny et al in Chapter 6 investigate determinants of cattle prices in seven livestock markets in southern Kenya. They report price formation is influenced by: where the market is in the market chain that brings livestock from producers to consumers in Nairobi; the purpose of purchase; whether or not it is a drought year; and animal specific characteristics. They place particular emphasis on the latter, as they find that there is currently no market incentive to conserve the Maasai Zebu breed, so that in situ conservation efforts of this genetic resource may have little impact. They also present information that can be used in developing an extension program to help producers target markets more effectively. Information on how animal characteristics impact price and price differences depending on market type can be used to help producers better define marketing strategies.

Desta et al in Chapter 7 develop this theme on linking producers to more remunerative markets as a way to increase their revenue. They describe recent efforts to actively link producers to better markets

in the rangelands of southern Ethiopia. There has recently emerged a flow of sheep and goats from the rangelands of northern Kenya and southern Ethiopia towards Addis Ababa, where many of these animals are sold onward in export markets (an issue also prominent in Chapter 11). A combination of seminars, exchange tours, support for groups, and a credit program were used to support participants in this emerging livestock market chain. This case study illustrates that through coordinated action over time livestock produced in pastoral rangelands can obtain a higher price by accessing particular market niches. They note both the promise and the difficulties of such an approach as revealed by their recent experience in the Borana plateau.

Chapter (8) by Mahmoud also illustrates the process by which pastoralists and traders can be linked to access more lucrative markets, although in this case study traders are transforming themselves into ranchers by leasing land strategically located near the Mombasa, Kenya market. In this study Somali traders from Garissa District, Kenya are shown to be increasingly concentrating their efforts on the growing Mombasa markets where they have strong cultural and religious (Islam) affiliations with butchers and slaughterhouse owners. To capture more value from this trade, pastoral traders have leased several ranches near the Kenya coast and have begun to fatten immature cattle purchased from the rangelands, to sell at the upper end of Mombasa and Nairobi markets. With added success in these enterprises, some lease owners are beginning to turn to full-time ranching and reduce their purchases from pastoral herds in the northeast. Mahmoud speculates in the chapter's conclusion that this trade in high-quality beef may launch the area into the even more demanding, overseas export trade.

Issues of cross border trade implicit in many of the earlier chapters are the explicit focus of Zaal et al in Chapter 9. They describe how cross border livestock trade operates within a policy vacuum and with mainly informal institutions. They contrast cross border livestock trade between Kenya and Uganda with trade between Kenya and Tanzania and show that the former is strongly shaped and frequently disrupted by widespread violence, often ethnic-based. They find in both areas that trans-border trade appears to be most beneficial for larger traders who have considerable capital for animal purchases and paying high transport costs, as well as control well-developed networks that are needed to be successful in such a risky business. The trade itself only minimally impacts producers and most small-scale merchants are restricted to local, low-priced markets. In the conclusion Zaal et al point out the need for improved market coordination by private sector actors and increased public-sector investments in security, transport, and market infrastructure.

Cross-border trade is also a theme highlighted in Chapter 10 by Little. Herders who raise the livestock that enters cross border marketing networks often have little understanding of such market networks. Given official neglect, or even opposition, to such trade, it is often the wealthiest who are able to use their position of power to benefit from the opportunities created by cross border marketing incentives. Drawing on his long-term research along the Kenya and Somalia borderlands, Little outlines how cross border trade presents particular challenges to both research and policy making. Methodological innovations, such as key actor interviews, opportunistic sampling with an assortment of actors, and participant observation, are required. In the conclusion, Little suggests that the first policy tactic for researchers and practitioners should be educational: to inform policy makers about the activity's scale and importance to local and national economies. Policies that acknowledge and encourage regional trade across borders—rather than discourage it—can strengthen local food security; increase collection of state revenues and investments in key market and transport infrastructure; and reduce price volatility and market imperfections.

Alkilu in Chapter 11 provides a broad overview of the interaction between policy and livestock marketing in Ethiopia. In particular, he describes how rapid policy shifts brought about by sudden changes in government have had significant impacts on livestock marketing. He places particular emphasis on how policies have impacted export oriented livestock marketing. In the final section of the chapter, he describes two recent programs that are of particular interest for the focus on cross border trade. In one case, the design of the project does not appear as if it will lead to any significant improvement

in livestock marketing. In the second case, there is reason to be hopeful. Aklilu also brings out a theme that underlies many of the other contributions in this volume – it is almost impossible to talk about improving livestock marketing in this area without also improving livestock health care. Policy makers must seriously consider re-engaging with the animal health sector and combining improvements here with efforts to improve livestock marketing.

The final two chapters discuss two issues of critical importance in current policy debates. Chapter 12 by Stuth et al describes the development of a livestock information market system in this region. They present the historical record of such systems in the area, noting they have not been particularly successful. They illustrate how recent advances in technology may allow a breakthrough addressing one constraint that has long bedeviled developing such systems – the time taken to gather, transmit, process, and disseminate information often means the information is of little value by the time it is delivered. They describe an approach to collecting and disseminating information on a broad set of factors that can influence marketing behavior that is designed to improve the connection between livestock producers and markets, improve the well being of participants in livestock markets, and improve market efficiency though improved decision making.

Morton's contribution in Chapter 13 analyzes the recent trend towards using livestock marketing as a crisis period intervention. After carefully considering what is meant by coping with a crisis, he turns to the question of the compatibility of such programs with traditional crisis period coping strategies. He suggests that the key issue is to insure that emergency livestock marketing interventions do not compromise pastoral mobility, the main risk management mechanism (both in drought and non-drought years) practiced by herders. While the evidence is still limited, there are cases from Kenya that Morton argues show that crisis-based marketing interventions increased sales and allowed some herders during a drought to recoup some value through sales. In terms of project design, the chapter suggests that the importance of mobility as a coping strategy implies a need to work closely with local pastoralists and private traders and incorporate their views on appropriate sites for purchasing, rather than with marketing agencies who might prefer to buy animals in market places distant from key seasonal grazing and water points.

Finally, in the book's last chapter (14) McPeak, Little, and Demment summarize the policy implications of the studies presented in this volume and identify critical areas needing further research. It ties together several of the key policy findings of the different chapters. The authors also describe what we currently know about livestock marketing in eastern Africa and what research questions remain to be answered.

Gender

First, three of the research efforts listed above have been led or had significant input made by women (Patti Kristjanson, Winnie Luseno, Sharon Osterloh, Maren Radney) and one also involved women enumerators (Eunice Lepariyo and Sarah Hirbo collected some of the data used in the chapter led by Winnie Luseno). These impacts are worth noting, as markets tend to be male dominated, so the presence of female enumerators and researchers in these markets has to some extent challenged existing gender roles, and secondly, since the literature on livestock markets tends to be written by males, this also challenges existing gender roles in the academic world.

More explicitly, the focus of research on market functioning and group formation will identify the role currently played by women participants, and also address the potential for increased involvement of women in markets. This is most directly addressed by the study of group formation in southern Ethiopia led by Layne Coppock, as many of these groups are women's groups involved in smallstock marketing.

Policy

As noted above, many of the findings are of direct importance to policy makers. We draw on the concluding chapter (14) of the volume to make the following points.

History matters. Government efforts to transform pastoral production into commercially-oriented enterprises and directly intervene in livestock markets have a history in eastern Africa dating back to the colonial period. For at least the past 50 years, policy makers have assumed that pastoral lands are overstocked and degraded and thus contain an abundant 'surplus' of animals that can be tapped through market incentives. The political actors, ideologies, and regimes have changed but the same basic story still persists—pastoralists need to sell more animals! In subtle and not so subtle ways, this volume challenges this old assumption that there is an untapped supply of animals on the rangelands that beg to be marketed. The editors of the volume don't believe the difficulty in increasing the sales volume reflects cultural attitudes toward marketing or animals, but rather the realities of pastoral production in these areas: herds are 60 to 70 percent female, herd losses of up to 50 percent over a period of a few months are disturbingly common, and there is growing evidence that there are thresholds in household herd size below which families are more likely to be driven over time towards total stocklessness than towards recovery. Instead, what the chapters in the book show is that while there may be small, incremental increases in herd off-take rates and aggregate sales volume in response to changing marketing opportunities, greater potential lies with the direction of animals towards markets where they obtain a higher value as traders and herders respond to new market opportunities. This would allow producers to improve their well being by redirecting animals from local to regional markets, or even to international markets, though the aggregate volume of marketed animals may stay the same or change only marginally. In short, the studies contained in the book indicate it is easier to identify policies and market opportunities that allow producers to 'sell better' rather than 'sell more'.

'Selling better' appears possible given the findings reported in the book. As noted in the chapters by Green et al, Radeny et al, Zaal et al, and Little, herders presently retain 50 percent or less of the terminal market price. This would suggest that there is room to improve the producer price by increasing market efficiency. What policies are suggested by the studies of the volume to allow producers to 'sell better' and capture more of this share?

New opportunities may also bring about changes in production techniques that could eventually lead to increased volumes, as in the case of the ranches Mahmoud discusses forming in costal Kenya. As we will note below, there are coordinated policies that can be implemented to change the production environment at a larger scale, thus creating the potential for increased sales volume. But for the most part what the studies in the volume find is that for the immediate future new market opportunities and changing policies create market opportunities that can be seized upon by selling animals at more remunerative prices, as illustrated by Desta et al and Zaal et al.

Macro policy matters. Macroeconomic policy making influences the market opportunities that are available to producers. This is perhaps most clearly brought out in the chapters in the middle section of the volume considering export marketing and cross border trade. The patterns of live animal and meat exports appear very sensitive to decisions made in capital cities, which is most clearly illustrated in the chapter by Aklilu. In this and other related chapters, it is clear that the controls the Ethiopian government placed on meat prices and marketing in the 1980s redirected animals to cross-border markets in neighboring countries. In addition, as Zaal et al and Little note, the flows of cross border trade are influenced heavily by the prevailing economic conditions and policies in the bordering countries. The flow of trade across a border can change direction, or even as noted by Desta et al flow in one direction for some species while in another direction for another species in reaction to different policies and economic opportunities.

Current polices regarding cross border trade in livestock and livestock products are not clear or consistent. The legal ambiguities increase inefficiency and the potential for markets to be disrupted by rent-seeking behavior. At the regional level, there is a need for the countries of this region to agree on an approach to cross border trade that will reduce the risks faced by participants. This type of agreement is of course easier discussed than implemented

given the political realities faced by countries in this region. In addition, as Aklilu stresses, little can be done with cross border marketing without also addressing veterinary policy. As the countries of this region revisit veterinary policy, it would be sensible to harmonize to the greatest extent possible these policies to minimize potential conflict.

Markets are very dynamic. The markets described in the volume are not static. They are changing, adapting, evolving markets. They are shaped by a number of opportunities and constraints which often occur outside the country where the animals are produced. As noted above, there are examples of cross-border livestock flows being quickly redirected; trade and production for high-value urban niche markets being rapidly transformed; and growth in chilled meat exports affecting local market arrangements in southern Ethiopia that confirm the dynamism of the trade. Policy will need to be adaptive and forward-looking, and research will need to be ongoing. There are emerging opportunities that can be identified by a clever marketing strategy and we predict there will continue to be opportunities that flexible and timely decision making will be able to exploit. On the other hand, as brought out by Aklilu, opportunities will not always last if not exploited, so that inaction may result in other market participants taking advantage of the opportunity, leaving domestic producers shut out of markets they could have benefited from if policy makers had taken a more facilitative stance.

Improved information delivery is possible. Given advances in technology, Stuth et al describe how it is possible to collect and deliver information on these changing market opportunities to producers at markets in remote areas in ways that were never before possible. The image of the small-scale trader at a distant border market receiving market information from a partner based more than 500km away or reading a text message on a mobile phone delivered from an automated server is likely to become an increasingly common fixture in key markets. The possibility for timely action in response to information about distant market opportunities is created by this flow in information. Since information flow is a component of market functioning, the changes in technology that delivers market information readily to market participants may be an important force in shaping the structure and dynamics of future pastoral markets.

Capacity to act on information is critical and needs support. Collecting and delivering the information does not always mean people will be able to act on it, however. Capacity building among producers and in production areas will be needed to translate this information into improved well being. As noted by Barrett et al, producers are relatively well informed about prices in local markets. And Green et al discuss results indicating access to information about prices does not translate into higher producer prices. If producers are not able to access distant markets it is unclear what benefit they will derive from improved information about these markets.

This is where capacity building plays a critical, complementary, role to information delivery. Desta et al. present one possible model for such efforts, as training and support for alternative income generation activities by creating trading groups allowed these groups to take advantage of new opportunities. Mahmoud, Zaal et al, and Little present evidence that in the absence of such efforts, the largest share of the benefits of improved information is likely to accrue to large scale, formal sector traders. However, even this situation may increase the value of livestock marketing overall, and still have some benefits for producers as well. More research contrasting the benefits and costs of producer groups forming to market livestock with existing trader networks will help define the kinds of policies that should be adopted.

The livestock market is composed of many different types of markets. Many of the chapters of the book point out that we are not looking at 'a livestock market', but really many different sub-markets in the livestock sector. Spatially, it is clear that markets in different areas do not operate in the same way, as can be seen by contrasts between Adugna, Green et al and Radeny et al and within different markets in a given area as stressed by Green et al and Radeny et al. There appear to be

major differences in the price obtained for animals with identical characteristics depending on where the animal is sold. One aspect of this is that locally defined marketing institutions can influence price formation as described by Green et al. Specifically, the auction based market delivers higher prices to producers, although it should be noted that Zaal et al indicate trader groups frequency seek to undermine efforts to introduce auctions. In addition, local markets differ in how prices are formed. The three studies on price formation in markets allow greater understanding of the relative impact of different animal characteristics on pricing in the specific local setting. With appropriate extension effort, these findings will allow livestock producers to better formulate herd management and marketing strategies, including potentially the formation of marketing groups as discussed above in order to obtain access to distant markets that offer higher prices. Price information systems may further support such marketing strategies as groups develop greater leverage with traders

It is also evident that within a given physical market location, specific sub markets operate. All three pricing studies find that the characteristics of the buyer and seller impact the price. Whether this is because there are qualitative differences in the animals in these different sub-markets that are not recorded or because there are differences in the nature of the negotiation between the buyer and seller remains as a topic for further research. Evolving market information systems based on animal condition and price, such as LINKS, may provide long-term market data that will allow such analysis. Another aspect of sub-markets existing within a given physical market is noted by Radeny et al and Zaal et al. Animals sourced from different areas and destined for different segments of the meat market are moving side by side through the overall marketing chain. This offers some opportunities for obtaining access to higher value market chains even in remote areas as the connection to higher value markets already exists for some producers operating in these areas.

The production environment plays a major role in marketing patterns. Barrett et al and McPeak stress the fact that household herd size is one of the main determinants of household marketing behavior. Herd size in this production environment is highly variable, due to 'boom and bust' dynamics. Given this finding, the argument that increased market volume can be used as a mechanism to regulate herd size appears to be getting it completely backwards. Rather, the evidence suggests changing herd size is one of the main driving forces behind changing market volumes, and if market volumes are to increase, it will require an increase in herd size under current conditions and practices.

This is not to say that offtake rates are immutable. As McPeak notes, over a longer period of time, offtake rates in Marsabit District appear to have almost doubled. However, the fact that herd sizes in the area he studies are by historical standards quite low means that the overall sales volume from the district has shown no overall upward trend over the past half century. While it may not be the case for all rangelands in the area that herd sizes are relatively low by historical standards, the evidence suggests this is the case for northern Kenya and southern Ethiopia. These low herd sizes have dampened whatever increase in volume would have come about by increased offtake rates and increased market orientation by producers. At the same time, as noted in McPeak's chapter, increased market integration has allowed herders to meet subsistence needs with these smaller herds that would not be possible to meet by directly consuming livestock and livestock products.

In a related fashion, Barrett et al argue that efforts to diversify the economy in pastoral areas is likely to lead to lower, rather than higher, sales volumes over time. As alternative options to generate income develop, reliance on livestock is likely to decline. As they point out, this may have positive implications for welfare of residents of these areas, but does caution that increased sales volumes may be less likely in the long run in more diversified economies. This also is a topic meriting further research.

As we noted above, we believe major constraints to 'selling more' lie in a constellation of factors influencing the production environment. Improved production technologies that reduce risks could

positively change the production environment, but also present some challenges. As noted by Morton, producers appear to be very interested in veterinary inputs during crisis periods (consistent with the indirect evidence on the interaction between veterinary supplies and price in Green et al), but as Aklilu notes veterinary policy is not currently well defined in Ethiopia and our own work in Kenya suggests major improvements could be made there as well. It would seem that better veterinary programs would at least partially address some of the 'boom and bust' dynamic in pastoral production in these countries because of the strong interaction between nutritional state, migration strategies during dry periods, and disease infection and response. Changing breed composition to improve marketability is another possible production strategy noted by Zaal et al and Radeny et al, although the latter study notes how this strategy presents problems for breed conservation. Zaal et al suggest different breeds may be entering different sub-markets, with improved breeds being sold in the highest value added sub-market. Improved feed availability is another production technology available, though Green et al report that it does not appear to have a positive impact on prices at local markets. However, Mahmoud presents an interesting response to this situation in costal Kenya, as traders have taken to developing fattening ranches of their own initiative. Clearly the availability, feasibility, and drawbacks of alternative improved production technologies in this environment merits further research.

That said, if improved marketing systems and production technologies are to alleviate poverty and improve the general welfare of herders, they must not compromise the main pastoral production and risk management strategy which is mobility. The discussion by Morton on how markets and mobility can be made compatible in emergency periods contributes to developing policies that allow flexibility in marketing without compromising flexibility in mobility. This issue is also implicit in many of the other studies, where the objective is to develop ways to improve markets without jeopardizing pastoral production systems. Barrett et al present a strong argument in their conclusion that mobile pastoralism continues to be the most viable activity possible in the arid and semi-arid areas they study, and McPeak argues that it remains the core economic activity of the area he investigates for the past half century and no viable alternatives appear poised to challenge it.

Outreach

There is no explicit outreach component of this project. We do however provide an opportunity for Desta et al to articulate their outreach and research effort to a wider audience.

Developmental Impact

Environmental impact. If we accept that livestock accumulation and low sales rates have an adverse environmental impact, improving market efficiency should reduce pressure on rangeland resources. As indicated above, there is reason to doubt the logic of this relationship. Instead, the research findings of this project indicate that improved livestock marketing will not automatically take care of environmental problems. Instead, direct, explicitly defined environmental efforts will need to be formulated.

Agricultural sustainability. Livestock marketing is a good example of the type of intervention that is extremely sustainable over time. Livestock marketing exists in the area, and has existed for quite some time. Clearly people are buying animals produced in livestock raising areas, and clearly people in livestock raising areas are selling animals in the market. The question is how do we reduce inefficiencies in this market to improve market functioning and improve the well-being of agricultural producers. There are very few physical inputs required, and not all that many capital costs. It is a question of finding out what is working, and identifying how to build upon success and eliminate inefficiency.

Contributions to US agriculture. There could be a few ideas on market efficiency or crisis period mitigation that have some relevance to US livestock production areas as we go forward. From a methodological standpoint, the discussion of

research methods for cross border livestock trade could have some applicability in the US, as could some of the price decomposition methods used in the market pricing studies.

Contributions to the host country. More than half (18 of 32) of our contributors are citizens of countries in eastern Africa and more than a third (13 of 32) are based in the eastern Africa region. Three chapters are sole authored by African researchers. This type of professional development and exposure allows recognition from outside of the host country of the contribution made by host country researchers. This project has also provided research opportunities that illustrate researchers who remain based in the host country or return to the host country after their studies will not be left out of future research projects conducted by international teams.

Linkages and networking. The contributors to this volume are based in seven different countries at twenty different institutions. We see this type of collaboration as extremely important, and have found that it leads to strong collaboration over time.

Collaboration with international research centers and other CRSPs. One project was awarded to a team based at the International Livestock Research Institute. In addition, major contributions have been generated from the PARIMA team and the LINKS team. Chris Barrett has also obtained some support for these efforts from his SAGA funds from USAID.

Other Contributions

Support for free markets and broad-based economic growth. This is a project based on improving market functioning by identifying and reducing inefficiencies through targeted research. Livestock raising is the key economic activity in arid and semi-arid areas. Improving livestock marketing offers the only viable potential base for a future of broad based economic growth in this area. While other activities will undoubtedly be important to the economic future of arid and semi-arid areas, none will be possible without ensuring the health of the core economic activity of livestock raising and marketing.

Contributions to and compliance with mission objectives. USAID is trying to move interventions in pastoral areas from "relief mode" to "development mode". They are looking at ways to ensure mission activities contributes to building a viable economic future that prevents humanitarian crises rather than address immediate humanitarian needs in ways that do not head off future crises. That is also the aim of this project.

Concern for individuals. Livestock marketing offers a way to build an economic future for areas that contain the poorest of the poor, and are marginalized in the national economy. We are identifying ways to improve the economic opportunities facing the individual livestock producer, and also the prospects for other individuals involved in different parts of the marketing chain.

Support for democracy. There is nothing explicitly in the project that addresses support for democracy, however the alleviation of poverty and the reduction in risk associate with improved markets is certainly an important step to set a favorable environment for democracy.

Humanitarian assistance. The research focuses on how livestock markets function during crisis periods and also how markets function to help people recover from crisis periods. The goal is to identify how to use market based interventions to minimize the need for humanitarian assistance that takes place outside normal marketing channels. This will both increase the sustainability of future crisis period interventions and reduce their unintended impacts on market functioning.

Collaborating Personnel

Ethiopia

Teressa Adugna is a professor in the Department of Agricultural Economics at Alemaya University, Alemaya, Ethiopia. He is currently on sabbatical leave and working for International Livestock Research Institute in Addis Ababa, Ethiopia. He can be contacted by e-mail at: TAdugna@ilrieth.exch.cgiar.org or tadugnab@yahoo.com.

Yakob Aklilu is director of pastoral livelihoods

program of the Feinstein International Center at Tufts University. He can be contacted at: tufts@africaonline.co.ke.

Abdirahman Ali is a research technologist for the LINKS project of the Global Livestock Collaborative Research Support Program and is based at the International Livestock Research Institute in Addis Ababa, Ethiopia. He can be contacted by e-mail at: abdiraham.ali@cgiar.org or by phone 251 11 6463215.

Getachew Gebru is a post-doctoral research associate for the PARIMA project of the Global Livestock Collaborative Research Support Program and the Department of Environment & Society at Utah State University. He is based at the International Livestock Research Institute in Addis Ababa, Ethiopia, and can be contacted by email at: G. Gebru@cgiar.org.

Seyoum Tezera is an outreach field assistant for the PARIMA project of the Global Livestock Collaborative Research Support Program. He is based at the International Livestock Research Institute in Addis Ababa, Ethiopia, and can be contacted by e-mail at: S. Tezerra@cgiar.org.

Europe

Rachel Andiema is a research associate at AMIDSt / University of Amsterdam, the Netherlands. She can be contacted by e-mail at: rachelandiema@yahoo.com.

Albino Kotomei is a research associate at AMIDSt / University of Amsterdam, the Netherlands. He can be contacted by e-mail at: Rachelandiema@yahoo.com.

John Morton is a professor at the Natural Resources Institute, University of Greenwich, UK. He can be contacted by e-mail at: j.f.morton@gre.ac.uk.

Eric Ruto is a Research Officer at the Kenya Agricultural Research Institute in Makindu, Kenya and a Ph.D. candidate at the Department of Agricultural Economics and Food Marketing, University of Newcastle upon Tyne. He can be contacted at by e-mail at: Eric.Ruto@newcastle.ac.uk.

Fred Zaal is a professor at AMIDSt / University of Amsterdam, the Netherlands. He can be contacted by e-mail at: afmzaal@yahoo.co.uk.

Kenya

Solomon Desta is a post-doctoral research associate for the PARIMA project of the Global Livestock Collaborative Research Support Program and the Department of Environment & Society at Utah State University. He is based at the International Livestock Research Institute in Nairobi, Kenya, and can be contacted by email at: S. Desta@cgiar.org.

Gatarwa Kariuki is a research technologist for the LINKS project of the Global Livestock Collaborative Research Support Program and is based at the International Livestock Research Institute in Nairobi, Kenya. He can be contacted by e-mail at: gatarwa.kariuki@cgiar.org or 254-20-422-3000

Patti Kristjanson is a Senior Agricultural Economist and Global Project Leader of the Poverty, Sustainable Livelihoods & Livestock Project at the International Livestock Research Institute in Nairobi, Kenya. She can be contacted by e-mail at: p. kristjanson@cgiar.org.

Hussein A. Mahmoud is a professor in Geography at Egerton University in Njoro, Kenya and a Post Doctoral Research Associate at the Max Planck Institute for Social Anthropology in Halle, Germany. He can be contacted by e-mail at: hamahm2@yahoo.com.

Maren Radeny is an Agricultural Economist and Research Assistant at the International Livestock Research Institute in Nairobi, Kenya. She can be contacted by e-mail at: m.radeny@cgiar.org.

Morgan ole Siloma is a Project Officer with SNV / Netherlands Development Organization, Nairobi, Kenya. He can be contacted by e-mail at: mesilo@yahoo.com.

Jacob Wakhungu is a senior lecturer in the Department of Animal Production at the University of Nairobi, Kenya.

New Zealand

Riccardo Scarpa is a professor in the Department of Economics, Management School, University of Waikato, N.Z. and senior Lecturer in the Environment Department, University of York, U.K. He can be contacted by e-mail at: rscarpa@mngt.waikato.ac.nz.

Tanzania

Margaret Kingamkono is a research officer at the Selian Agricultural Research Institute in Arusha, Tanzania. She can be contacted by e-mail at: mkingamkono@sari.co.tz or 255-27-2505210.

United States

Christopher B. Barrett is a professor in the Department of Applied Economics and Management at Cornell University in Ithaca, NY. He can be contacted by e-mail at: cbb2@cornell.edu.

Marc F. Bellemare is a Ph.D. candidate in the Department of Applied Economics and Management at Cornell University in Ithaca, NY. He can be contacted by e-mail at: mfb24@cornell.edu.

D. Layne Coppock is a professor in the Department of Environment & Society at Utah State University in Logan, UT. He is Lead Principal Investigator on the PARIMA project of the GL-CRSP. He can be contacted by email at: lcoppock@cc.usu.edu.

Montague W. Demment is a professor in the Department of Plant Sciences at the University of California, Davis and director of the Global Livestock Collaborative Research Support Program (GL-CRSP). He can be contacted at: mwdemment@ucdavis.edu.

Alan M. Green is a Ph.D. candidate in the Department of Applied Economics and Management at Cornell University in Ithaca, NY. He can be contacted by e-mail at: amg84@cornell.edu.

Abdi Jama, Ph.D., is an assistant research scientist in the Department of Rangeland Ecology and Management at Texas A&M University and Greater Horn of Africa Coordinator for the LINKS project of the Global Livestock Collaborative Research Support Program. He can be contacted by e-mail at: aajama@cnrit.tamu.edu or phone 1-979-845-3359.

Robert Kaitho, Ph.D. is a assistant research scientist in the Department of Rangeland Ecology and Management at Texas A&M University and Greater Horn of Africa Coordinator for the LINKS project of the Global Livestock Collaborative Research Support Program. He can be contacted by e-mail at: rkaitho@cnrit.tamu.edu phone 1-979-458-3215.

Peter D. Little is a professor in the Department of Anthropology at the University of Kentucky in Lexington, KY. He can be contacted by e-mail at: pdlitt1@pop.uky.edu.

Winnie K. Luseno is a Research Health Analyst at RTI International in Research Triangle Park, NC. She can be contacted by e-mail at: wluseno@rti.org.

John G. McPeak is a professor in the Departments of Public Administration and Economics at Syracuse University in Syracuse, NY. He can be contacted by e-mail at: jomcpeak@maxwell.syr.edu. He is Lead Principal Investigator on the LiTEK project.

Sharon M. Osterloh is a Loan Officer with the Wisconsin Women's Business Initiative Corporation in Madison, WI. She can be contacted by e-mail at: sharon.osterloh@gmail.com.

Jerry Stuth, Ph.D. is the Kelleher professor in the Department of Rangeland Ecology and Management at Texas A&M University. He is Lead Principal Investigator on the LINKS project of the GL-CRSP. He can be contacted be e-mail at: jwstuth@cnrit.tamu.edu or phone 1-979-845-5548.

Jimmy Wu, Ph.D. is a systems analyst/programmer, in the Department of Rangeland Ecology and Management at Texas A&M University. He can be contacted by e-mail at: jianjiawu@tamu.edu or phone 1-979-458-1480.

Collaborating Institutions

Department of Public Administration
Maxwell School, Syracuse University
Syracuse, N.Y. 13244
Telephone 315-443-4000
Fax 315-443-9721

Department of Anthropology
University of Kentucky
Lexington, KY 40506-0024
Telephone: 859-257-6923
Fax: 859-323-1959

Lead Principal Investigator

John McPeak, Assistant Professor, Department of Public Administration, Maxwell School, Syracuse University, Syracuse, NY 13244. Telephone (315) 443-6146, Fax (315) 443-9721; Email: jomcpeak@maxwell.syr.edu.

Improving Pastoral Risk Management on East African Rangelands

Narrative Summary

This was the eighth year of work for the pastoral risk management (e.g., PARIMA) project. The overall goal of our project is the discovery and application of knowledge pertaining to improving risk management—and thus enhancing livelihoods—for pastoral and agro-pastoral people in northern Kenya and southern Ethiopia. Foundation concepts include the exploration of opportunities to better diversify incomes and assets and how to improve access to natural resources, information, and various public services. The year is best characterized by the following achievements: (1) Twenty-one publications were produced including a dissertation, two theses, peer-reviewed papers, training manuals, popular articles, and nine GL-CRSP Research Briefs; (2) nineteen professional presentations were given at venues in east Africa, Europe, and the USA; (3) three students received graduate degrees with partial support from the GL-CRSP, with another 13 students in the pipeline at universities in the USA, Kenya, and Ethiopia; (4) four meetings were sponsored or co-sponsored by PARIMA in Kenya and Ethiopia that focused on non-degree training for research staff of national organizations with 67 attendees overall; (5) another 17 events were held in southern Ethiopia that focused on non-degree training for pastoralists, development workers, and decision-makers—also sponsored or co-sponsored by PARIMA under the auspices of the USAID Mission to Ethiopia—with 2,554 attendees; (6) an annual survey of 330 pastoral households was successfully completed in southern Ethiopia and northern Kenya, a continuation of work started in 2000 that will provide an unparalleled time series of data concerning dynamics for pastoral risk management; and (7) progress continues to be made in establishing working relationships among PARIMA scientists, policy makers, and donors in east Africa and the USA. We have remained true to our original problem model. Work plans and outputs in Year 8 are on track with what we outlined in the original project proposal. Team members have been very productive and creative with resources provided by the GL-CRSP.

Research

Activity One: Research on Risk at the Individual, Household, and Community Level

Problem Statement and Approach. One of the core issues investigated by the PARIMA project is the extent to which pastoralists share a common perception and experience of risk. The common assumption is that most risk experiences are common to most pastoralists. This assumption has important implications for the way that interventions are structured. When risk is broadly shared across a population, external resources are essential to enable recovery from shocks and rural financial, marketing, and social insurance systems are prone to failure. When the risk experience is highly variable (idiosyncratic) within a population, local systems have greater capacity to manage risk internally so long as a basic physical and institutional infrastructure is in place. Therefore, one of the first research activities of PARIMA has been to explore intra-regional variability in risk exposure and risk perceptions. Two different research efforts have contributed to this activity. We started with a participatory risk-mapping activity documented in GL-CRSP Annual Reports for 1999 and 2000. This was followed by a more detailed, repeated survey implemented for 330 households in 11 communities (six in Kenya and five in Ethiopia) using a cluster sampling approach. Five of these communities are Boran, with one each from

the Rendille, Ariaal, Il Chamus, Gabra, Samburu, and Guji. The survey was launched during March 2000 and was successfully repeated on a quarterly basis over the next two years, ending in June 2002. Survey work has been devoted to: (1) delineating sources of risk affecting individuals, households, and communities; (2) understanding the effectiveness of various indigenous tactics for reducing risk exposure such as livestock accumulation, livestock mobility, and social insurance systems; and (3) understanding the effectiveness of various introduced tactics for reducing risk exposure such as livestock marketing, access to rural financial networks, economic diversification, and use of relief as well as other forms of external assistance. Communities have been stratified and purposively chosen so as to capture important differences in agro-ecology, access to towns and infrastructure, and ethnicity. Individual-level surveys have not only been fielded to household heads, but also to a randomly selected junior male and female adults from each household in order to illuminate gender and generation differences that condition risk exposure and response. The survey instruments capture information on household structure, asset holdings, activities, consumption, mobility, livestock transactions, experience with raiding, risk assessments, past risk exposure, etc. Effort has been made to capture actual behaviors as well as risk perceptions. Updated descriptions of survey findings have been documented in GL-CRSP Annual Reports for 2001 through 2004.

Progress. In 2003 we embarked on an annual survey (reduced frequency) of the same 330 households with an additional goal of capturing dynamics related to the drought recovery cycle. Work on this activity has been dominated by data processing and writing in 2004-05. Co-leaders for this activity include Drs. Chris Barrett, John McPeak, Peter Little, Getachew Gebru, and Cheryl Doss. Writing and synthesis have largely occurred in the USA. Field data collection is ongoing in northern Kenya and southern Ethiopia. Critical supervision of survey data collection has been provided by Dr. Getachew Gebru (Ethiopia) and Mr. Rueben Lemeunyete (Kenya). Outputs from this activity remain on target.

This activity has contributed to three publications in the past year, including one Research Brief (Santos and Barrett), one master's thesis (Lentz) and one doctoral dissertation (Hogset). See Publications and Training for details. There have also been two presentations related to Activity 1, with one each by Barrett and McPeak (see Abstracts and Presentations). In this report we add some detail and new insights pertaining to this activity, with a focus on a study conducted by Paulo Santos and Chris Barrett of Cornell University.

Herd Dynamics, Social Networks, and Informal Transfers Among Southern Ethiopian Pastoralists. Pastoralism is a risky activity. Droughts, in particular, drive a cycle that typically leads to sharp decreases in herd size that is followed by a process of slow accumulation of animals as better climatic conditions return. Recent research shows that individuals face different prospects for recovery from drought shocks—and different long-run steady state herd sizes—depending on their initial livestock holdings. Herd history data from pastoral households in southern Ethiopia over the period 1980-97 identified a sigmoid-shaped animal accumulation pattern between drought-induced herd crashes. Pastoralists who start the process being relatively wealthy (with herd sizes at around 40 cattle) tend to recover their cattle holdings relatively quickly following droughts, as long as they were able to avoid a calamitous loss. Those who are shocked below the estimated critical herd size of roughly two cattle per person (or 12 to 15 head per household), however, tend not to recover but, instead, to collapse towards a lower-level equilibrium herd size of only one cow. These dynamics suggest the existence of a "poverty trap." Those in the low-level equilibrium are, on average, unable to grow their herds, mainly because they become involuntarily sedentarized and cannot easily accumulate cattle when they are unable to take advantage of spatio-temporal variability in forage and water availability through opportunistic migration. A body of emerging work suggests that the existence of poverty traps and critical asset thresholds affect risk-management behavior of pastoral households. For example, those near the critical threshold tend to increase savings (and reduce short-term consumption) in an effort to escape a

Table 1. Knowing and giving- a hierarchial relation for Borana pastoralists in the southern Ethiopian rangelands.[1]

		Give gift to match		
		No	Yes	Total
Know	No	65	3	68
Match	Yes	370	123	493
	Total	435	126	561

[1] *Based on survey of residents in four locations. The entry "65" indicates that 65 of 68 respondents (96%) would not give cattle to a person they did not personally know. The entry "123" indicates that 123 out of 493 respondents (25%) would give cattle to a person they knew. (Source: Santos and Barrett - in press).*

collapse towards poverty.

Does the existence of poverty traps also affect the way people traditionally assist each other through gifts and loans that may attenuate the impact of a negative shock? Using detailed data on household characteristics, livelihood choices, asset dynamics, and social networks and transfers collected from four sites in southern Ethiopia, we explored whether pastoralists perceive the sigmoid-shaped animal accumulation dynamics evident in herd history data, and whether this affects social aspects of risk management.

Using data on pastoralists' expectations of herd size transitions under different rainfall states we established that Borana pastoralists indeed appear to understand the sigmoid-shaped animal accumulation dynamics that characterize their system. Moreover, their responses suggest that multiple- dynamic equilibria arise due to adverse shocks associated with drought years, but this is only for pastoralists having intermediate-sized herds (between 16 and 39 head per household). These are the prime candidates for "safety nets" to help prevent a collapse into destitution when drought shocks occur.

Social transfers—gifts between households—are a longstanding means of managing shocks after the fact. But not all herders have equal access to such transfers. Table 1 displays data related to who knows whom (social network structure) and who helps whom (social transfer patterns). Three key facts emerge. First, not everyone knows everyone else, even in an ethnically homogeneous setting in which virtually everyone pursues the same livelihood. Second, social acquaintance is clearly a necessary condition for one's willingness to make a transfer. People don't give livestock to those they don't know. Finally, mere acquaintance, although necessary, is clearly insufficient for mobilizing transfer support. In just one quarter of the cases where the respondent knew the match, was he or she willing to give an animal to the person. Plainly, the "romantic image" of homogeneous communities in which everyone knows everyone else and is willing to help everyone else is a fiction, at least in this setting.

Econometric analysis of the social transfers that do occur exhibit an interesting pattern that seems to reflect behavior in response to the existence of a poverty trap. Transfers flow in response to herd losses, but this effect depends heavily on the wealth of the prospective recipient. If his or her wealth is too low—more precisely, below five cattle and thus in the vicinity of the low-level equilibrium, signaling limited expected capacity to reciprocate in the future—then there is no expected transfer in response to herd loss. Only losses that leave an individual near the critical threshold, i.e., at a point where a modest transfer from another household can nudge the recipient back onto a recovery and growth path, trigger social transfers. The social safety net seems to operate only for those households of at least moderate livestock wealth, and not for the poorest members of society.

Wealth dynamics affect social transfers largely by conditioning a herder's social network. Destitution (or owning a cattle herd size persistently below five head) has a strongly negative and statistically significant impact on the probability of "being known" within the community. Since the possibility of receiving any assistance from others depends fundamentally on being known by others, (Table 1), the "social invisibility" of the destitute explains much of their exclusion from social transfer networks. This

is corroborated by other social-science accounts that report exclusion from one's community as a traditional way that east African pastoral communities respond to persistent destitution. The triage that results leads to a social safety-net system that exacerbates a poverty-trap syndrome.

Wealth dynamics—in the form of livestock assets—have a profound impact upon the structure of informal institutions that these pastoralists use to manage risk. In particular, the existence of asset thresholds at which wealth and welfare dynamics bifurcate highlights the critical importance of external implementation of additional safety nets that are designed to catch households reeling from drought shocks so as to enable them to recover and keep from falling into long-term destitution. Borana pastoralists recognize these patterns in their own descriptions of herd dynamics and act in such a way that marginalizes those who are trapped in persistent poverty, concentrating transfers on those who are below, but sufficiently near, the unstable threshold for asset transfers to make a difference in terms of the recipient's viability as a pastoralist. The apparent social invisibility of the persistently poor appears to be the corollary of a safety net approach that necessarily involves triage.

These observations clearly open a window for public intervention in attacking persistent poverty, as it squarely addresses one common criticism of outside interventions: that they "crowd out" private transfers, disrupt extant social transfer systems, and fail to produce net positive transfers to the poor.

Activity Two: Thematic Investigations Dealing with Conflict, Natural Resource Management, and Livestock Marketing

Problem Statement and Approach. The broad objective of this activity has been to investigate how support systems such as livestock marketing, rural finance, natural resource tenure, indigenous social networks, and provision of climate forecast information affect pastoral risk management in our study region. This work is packaged as ancillary studies to the major survey described under Activity 1. Work was done by African and American graduate students matriculated at US universities, African collaborators with local non-governmental and governmental institutions, and recent degree-holders previously educated with PARIMA support. Studies of natural resource tenure and issues pertaining to cross-border livestock marketing dominated our work in the past year. This research has involved several social science approaches including household surveys, community focus groups, and key informant interviews.

Progress. Co-leaders of this activity include Drs. John McPeak, Peter Little, and Chris Barrett with contributions from Kenyan nationals Hussein Mahmoud, Guyo Haro, Godana Doyo, and Kioko Munyao. This activity has led to 10 publications in the past year. These include one master's thesis (Munyao), five peer-reviewed papers (Barrett and Luseno, Little, Lybbert et al., McPeak, and McPeak et al.), and four Research Briefs (Haro et al., Little and Mahmoud, McPeak, and Munyao and Barrett). See details in Publications and Training sections. Two presentations by Little were also directly related to this activity (see Abstracts and Presentations). Some research highlights are as follows.

Linkages Among Community, Environmental, and Conflict Management: Experiences from Northern Kenya. Environmental degradation in pastoral areas has long been viewed as arising from the common property nature of land tenure in such areas. The basic logic of this argument is captured by Hardin's metaphor of a village commons. Each individual only considers private benefits and costs of placing livestock on common land and does not take into account the cost these animals impose on other herders. From a natural resource management perspective, the imposed cost takes the form of environmental degradation. This perspective influenced the design of what has been termed the "ranching phase" of pastoral development efforts. The objective of these efforts was to transform pastoral production into commercialized ranching. As has been noted elsewhere, the failure of this approach became evident by the mid 1980s. Frustration with this record led to a new emphasis on involving pastoral producers in development project design. This approach reflects both the overall movement in development policy to increased participation

by communities and a growing appreciation by researchers and practitioners of the inherent logic of traditional management practices.

One difficulty in adopting this approach in the pastoral areas of northern Kenya is that specifying the relevant community to manage a given natural resource is a formidable task. There are multiple levels of social organization that can legitimately claim the right to make decisions about natural resource use. Decisions about natural resource use are made at the household level, at the camp level (which is a collection of households), at the neighborhood level (which is composed of multiple camps), and at the level of a grazing area (which represents a collection of neighborhoods). In addition, strict definitions of geographic boundaries are not emphasized by pastoral groups. So, not only can a given natural resource have multiple levels of social organization claim authority to manage it, but also multiple groups at a given level of social organization can claim authority to manage it as well. These multiple claims can be particularly problematic when the multiple claimants are from hostile groups. Large areas of the rangelands of northern Kenya are unused due to the possibility that use of these areas will expose oneself and one's family to violent attack. In the northern Kenyan rangelands such attacks are an ever-present threat.

The effort by German bi-lateral assistance (GTZ) in this area has been built on efforts of the UNESCO-funded Integrated Project for Arid Lands (IPAL) that operated in Marsabit District from 1976-86. The IPAL work culminated in an integrated resource assessment and management plan produced in 1984. The plan did not have a major impact on natural resource management in the area, and only a few elements were implemented. The GTZ began their project here in 1990 and one objective was to improve natural resource management. They began by commissioning a study of traditional grazing systems and using this study to develop an extension and education plan to achieve the goal of improved natural resource management.

Following completion of the study and development of the plan, the project began targeting local administrative and civic leaders, traditional leaders, and primary schools that would influence neighborhoods to form "environmental caretaker committees." This approach was reassessed in 1995, as the targeted individuals were often unable to persuade communities of the need to form natural resource management plans because there were questions about who in the neighborhood had a legitimate right to make such management decisions and what resources belonged to a given neighborhood. From 1996-98 a new approach of project-supported environmental management committees formation was adopted where these neighborhood committees were explicitly designed for managing natural resources using traditional definitions of neighborhoods. While these groups met with some success, they faced problems due to ambiguity about which natural resources belonged to which neighborhood, and also due to the fact that different neighborhood committees developed rules so that rules were often inconsistent. In 1998-99 the project brought together representatives from the different neighborhood committees to harmonize management rules at the level of traditionally defined grazing areas. When these representatives met, they were able to develop a harmonized management protocol that defined rules and sanctions. Notable elements of this protocol were measures to:

- Manage water resources
- Manage grazing land use by local residents
- Manage grazing land use by non-residents
- Manage use of tree species
- Establish rules over charcoal making
- Manage wild fires
- Manage movement of diseased livestock
- Develop communication mechanisms and dialog with the local community
- Develop communication mechanisms and dialog with neighboring communities
- Develop communication mechanisms and dialog with formal administrative structures, and
- Protect wildlife.

However, participants in these meetings argued that this protocol left out measures to address one of the key factors leading to unsustainable resource use—that of insecurity. They argued that they were overusing some resources in the rangeland because vast areas in the rangeland were not used due to

insecurity. While the rules and sanctions contained in the protocol would help, they argued that ultimately they would not work, as rest and rehabilitation of currently overused areas would only be possible if currently underutilized areas were made accessible.

In response, from 1999-2002 the project supported consultative meetings that brought together representatives from different grazing areas together with governmental and non-governmental authorities. The representatives of the grazing areas were brought together regardless of ethnic identities and administrative boundaries. They were asked to describe the causes of conflict, define measures to reduce conflict, and develop rules to manage conflict when it occurred. These were each discussed, and after agreement was reached, the consensus view was translated into local languages and distributed to all relevant resource management units. Members from the environmental management committees were selected to oversee the implementation of the agreement.

Currently, the environmental management committees continue their work. Tree protection and regeneration have been particularly successful accomplishments in many areas. In addition, efforts at reserving dry-season grazing areas, protection of wildlife, and waste management have all been successfully implemented in certain communities. Coordination across communities and underlying questions about the legitimacy of these committees continue to be challenging.

Conflict management efforts have also met with some success. Inter-ethnic grazing cooperation has increased. Project workers estimate that up to 35% of the district that was formerly unused due to concerns about insecurity was in use after the conflict management meetings were held. Two murders across ethnic lines were dealt with through the agreed-upon protocols, thus preventing an escalation into the spiral of violence of attack and counterattack that such murders can trigger. While these accomplishments are important to note, it is also clear that the peace is fragile. Maintaining the peace will be a major challenge given the history of mistrust across groups, the inability to control individuals from one's own ethnic or language group who come from outside the area and attack neighbors, and presence of local residents who, for various reasons, find benefits when conflict occurs.

Improvement in the well being of residents in pastoral areas is possible by working with pastoral communities and allowing them to define their own plans. This does not lead to a major transformation of pastoral society, but rather allows people to build on the existing structure of society to improve their lives. However, as the GTZ experience in Marsabit District illustrates, it is not easy. It requires coordination that can only come from working at multiple levels of social structure simultaneously as well as from working in multiple areas at once. This allows coordination across units when there is ambiguity about who has the legitimate right to make rules over a given resource. It also requires adaptability by development agents, as what began as an environmental management program transformed into a conflict management program. And finally, it must be recognized that accomplishments can be fragile. Environmental management committees have had visible impact on the environment, but it remains to be seen how sustainable such efforts are. Likewise, while there has been some initial success in the conflict management efforts, it also remains to be seen how sustainable these efforts have been.

Decentralization and its' Effects on Pastoral Resource Management in Northern Kenya. The Kenyan government's policy focus on rural development, initiated in the mid 1980's, as well as the advent of multiparty democracy in the early 1990's, created an impetus for devolving decision making to local levels. Discussions about and initiatives towards decentralization of governance at the district, division, and location levels have significantly progressed during the past decade. At the same time, governmental and non-governmental organizations have often targeted community-based groups to implement development projects and promote transparency and accountability. This has spawned a multitude of community groups, some of whose existence depends on donor funding. In pastoral areas this decentralization process does not automatically foster well informed, equitable, and representative decision-making. Such alternative institutions sometimes displace traditional bodies that derive their legitimacy from local people. This

problem can be especially acute when new forms of governance give more power to settled residents and diminish the influence of important, but transient, traditional resource users such as pastoralists. This research explored these issues in the Hurri Hills area of Marsabit District where externally imposed changes in governance have combined with a World Bank Global Environmental Facility project to alter local patterns of natural resource management. We used a combination of research approaches including focus group methods and key informant interviews. Seven community groups were involved, including two women's groups, two environmental management committees, one youth group, and two groups of traditional elders. In addition, some staff members of various governmental and non-governmental organizations were interviewed.

The Hurri Hills of northern Kenya provides an example of how the effects of decentralization can unfold. Traditionally, the Hurri Hills were used by nomadic Gabra pastoralists and their herds at certain seasons of the year. Destitute Borana and Gabra households could settle in the Hurri Hills, but this was typically on a temporary basis. Land allocation had to be negotiated with the Gabra nomads.

The Kenya government established the Hurri Hills "location" in 1987, and a "sub-location" was designated in 1997. These administrative units were intended to bring governmental decision making closer to the people. One major outcome was the establishment of a new Land Allocation Committee at the location level. This Committee provided a new mechanism to provide plots to individual applicants and the rate of land disbursement rapidly increased. Over 60% of our survey respondents had been allocated land via the Land Allocation Committee, compared to less than 30% who had been allocated land by the traditional system.

People who received plots from the Land Allocation Committee were also given permanent and legally defensible rights to the land. In contrast, allocation under the traditional system always remains subject to periodic review. This process has therefore given greater legitimacy to the settled people in the Hurri Hills and has been associated with dramatic increases in the area under cultivation (Figure 1). While there may be dual causality in this relationship—in other words, pressure to increase

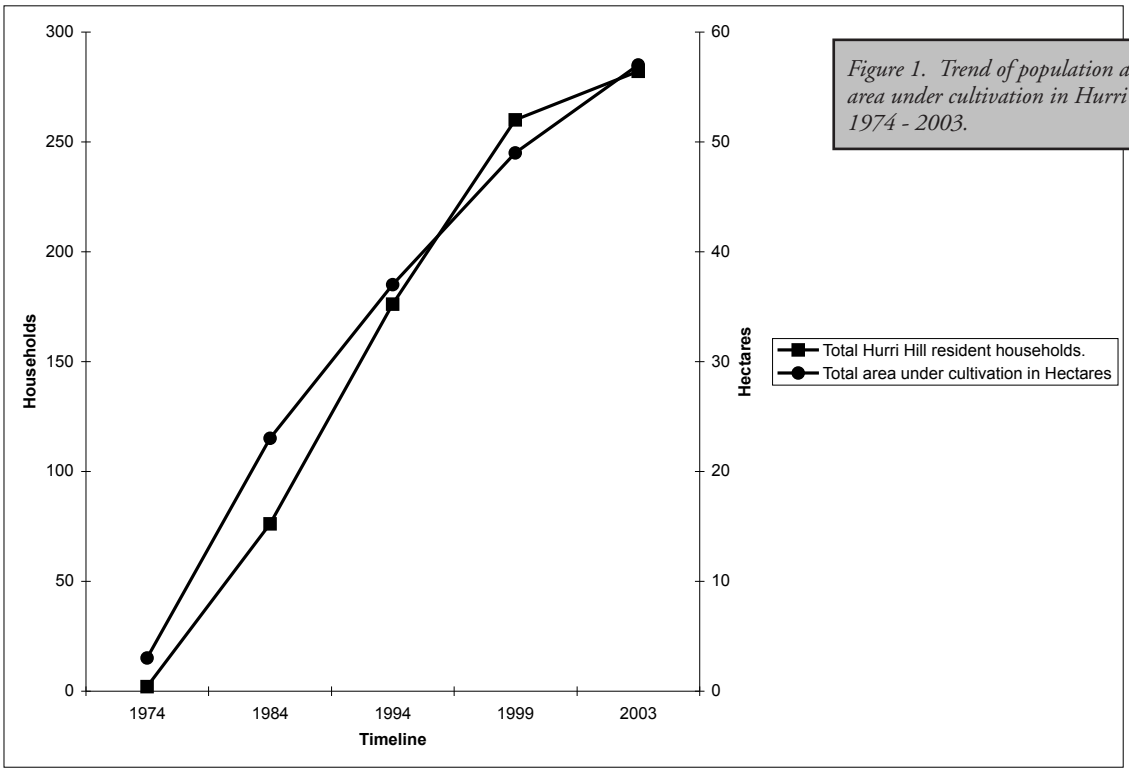


Figure 1. Trend of population and area under cultivation in Hurri Hills, 1974 - 2003.

cultivation could help increase demand for legal empowerment of the Land Allocation Committee—the impacts of this process have negatively impacted resource use and land-use planning influence of traditional Gabra pastoralists. Permanent settlement has compromised the access of Gabra herds to seasonally important forage resources.

In this case decentralization has not taken into account the spatial and temporal variability of rangeland resources. Decentralization has created artificial resource-use boundaries that have complicated administrative processes and fueled conflict among local people. Decentralization has enabled government to extend its control over local communities while at the same time gaining political mileage through the rhetoric of bringing government services and development closer to the people. Natural resources in the Hurri Hills have traditionally been managed in a communal fashion; decentralization has created new decision-making bodies officially sanctioned by government and endowed with legal authority to wield extensive power.

The creation of entities such as Land Allocation Committees has occurred within a wider framework where more and more community-based groups are emerging. For example, the number of community groups officially registered in the Hurri Hills has increased from virtually nil in 1975 to 25 by 2003. On the positive side, some groups have provided a voice for otherwise voiceless groups—especially women and young people—in an otherwise highly paternalistic pastoral community. But some groups have also created alternative centers of power within communities, thereby eroding the effectiveness of traditional community institutions. The recent emergence of a better educated, more politically aware class of elites among local communities on one hand, and the weakening of traditional institutions on the other, has been a source of conflict and ambiguity in most community-based resource management efforts in the Hurri Hills. This is because most initiatives in decentralization and community empowerment treat these two categories of people as a single entity, and this disregards their varied sources of legitimacy. In such cases, enforcement of community sanctions fails to achieve very much because the two groups differ in terms of cultural norms and legal status despite overlaps in resource-management mandates.

Another example from the Hurri Hills is the formation of an Environmental Management Committee (EMC) intended to spearhead environmental management and biodiversity conservation efforts. The EMC concept, introduced in the area three years ago, drew inspiration from experiences of GTZ working with the pastoral Rendille in southwest Marsabit District. Through the Marsabit Development Program (MDP), GTZ pushed for the establishment of EMCs to deal with problems of natural resource management and localized environmental degradation caused by overstocking and settlement at water points and trading centers. Ideally, the EMC membership is comprised of traditional leaders, women, and youths within an identifiable neighborhood based on shared resources. The EMC is charged with mobilizing and raising environmental awareness for user groups. It does this by helping organize meetings to elaborate and disseminate environmental management protocols aimed at minimizing natural-resource related conflicts and facilitating participatory assessment of implemented actions and measures. In most other parts of Marsabit District where this model is used, the EMC mainly deals with pastoralists and settled communities near water points and trading centers that comprise only one ethnic group. In the case of the Hurri Hills, however, the presence of ethnically diverse resident cultivators (Boran) and non-resident pastoralists (Gabra) greatly complicates the EMC's work and undermines its perceived legitimacy. In addition, as noted by Haro et al. (2005), the limited cultural precedence for a body such as an EMC to define new rules for resource use has led some community members to refuse to accept the final authority of the EMC. The EMC's dependency on elders or the authority of a local chief to enforce sanctions for non-compliance with conservation by-laws has also been a problem. In addition, its inability to offer incentives for compliance has seriously compromised its effectiveness. Traditional enforcement of resource use restrictions has relied on community elders, and compliance may occur as a result of fear of being ostracized or cursed. Thus, in cases such as that of

the Hurri Hills where support of the elders is not assured, the effectiveness of community-based efforts becomes doubtful.

Overall, decentralization in the Hurri Hills seems to have had several unintended and undesirable consequences. Increased settlement and cultivation has impeded traditional pastoralists' access to customary livestock migration routes and displaced them from critical wet-season grazing areas, thereby increasing the vulnerability of pastoral herds to drought. Conflicts over water and crop damage by livestock have also occurred. Increased settlement has accelerated localized environmental degradation due to greater demand for fuel wood and building timber as well as increased soil erosion due to cultivation.

Case studies from around the world indicate that decentralization intended to improve poor peoples' livelihoods and better conserve critical natural resources is often inadequately implemented. Many such reforms result in resource privatization, dilution of traditional authority, and a transfer of local power to central government. The creation of new, powerful institutions thus can complicate resource management, much as they did in the colonial era.

In the Hurri Hills the presence of traditional pastoral elders in new resource management organizations has been a compromise aimed at building community consensus in natural resource management. But in reality the influence of the elders in these settings is minimal. Rather, the interests of the settled residents have proven decisive in determining the outcomes of resource management decisions.

The capacity of local communities to self-govern their natural resources in ways that promote conservation and equity cannot always be assumed. Community-based approaches normally work best when there are strong local systems of social control to enforce access restrictions. The persistence of the Gabra traditional institutions, such as the Yaa Council of Elders, despite years of government-sanctioned competition, attests to their resilience. The overarching influence of entities such as the Yaa Council of Elders in the socio-political and economic life of the Gabra community is a testament to their credibility. Linking political and development decentralization strategies to existing community institutions will not only strengthen these institutions, but will also enhance the legitimacy of such strategies.

In the case of northern Kenya in general, and the Gabra in particular, the on-going national constitutional review process can be used to advocate for proper implementation of the devolution of state authority to local peoples. The experience of pastoral communities elsewhere has shown that when critical decisions are made at the local level the needs of pastoralists can be addressed promptly and meaningfully. Yet governments and development agencies must pay closer attention to the array of local interests and the prospect for competing centers of power within local jurisdictions and what this could imply for changing land use patterns, equity, and security. Support for decentralized resource management will require a re-conceptualization of the role of the state and other local institutions in resource management. In many cases traditional or grass roots institutions may be more successful than those imposed by the state. In some cases, however, state intervention is necessary to address the needs of otherwise marginalized groups in local communities. Creating bottom-up processes from existing top-down initiatives is difficult as communities are socially heterogeneous and prone to domination by local elites. Decentralizing governance of natural resources requires central government support and positive action in terms of policy and institutional reforms. Influencing the policy environment is complex and highly dependent on the willingness of government to listen to its citizens. The highly disenfranchised nature of many pastoral communities makes this even more critical. In addition, a deeply ingrained bias against pastoral communities and pastoral regions militates against the ability of pastoral advocates to effectively lobby for policy change.

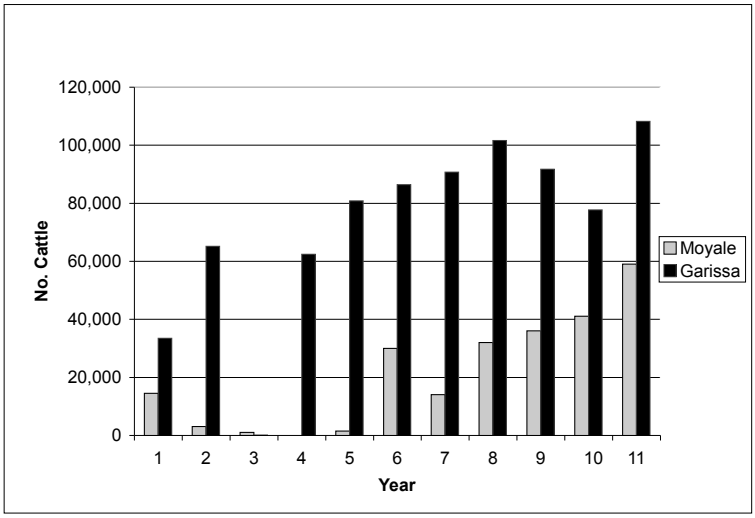
While there are many examples of successful decentralization strategies at local level, the challenge remains how to disseminate and scale-up these successes in a sustainable manner. Wider appreciation of pastoralism as a viable livelihood system that is very well suited to the ecology of rangelands may

better inform attempts to decentralize natural resource management in arid and semi-arid lands.

Cross-Border Cattle Trade along the Somalia/Kenya and Ethiopia/Kenya Borderlands. Trans-border cattle trade from pastoral areas has a long history in the Horn of Africa, but its scale and complexity have grown significantly in recent years, especially as the region's urban populations and meat consumption have grown. Currently the commerce accounts for approximately 26% of total beef consumption in Kenya. Unofficial imports from pastoral areas of Somalia and Ethiopia make up the bulk of this trade, with cattle imports from Tanzania also playing an important role. It has been estimated elsewhere that the cross-border trade with Somalia alone encompasses an estimated 16% percent of beef consumed in Nairobi, Kenya, the region's major urban market. This effort addresses cross-border cattle trade in the Ethiopia/Kenya (E/K) and the Somalia/Kenya (S/K) borderlands. It will be shown that while there are important similarities in the two markets and their inherent risks, there are significant differences that relate to institutional, production, and social variables. The paper also argues that trans-border trade and its significance remain poorly understood by policy makers, which results in ambivalent public actions and attitudes. This study also draws on research done by the authors in northeastern Kenya (1996-2002) and northern Kenya/southern Ethiopia (2001-03).

Unofficial cattle imports from Ethiopia and Somalia to Kenya rapidly rose in the 1990s and 2000s. The impetus for this growth stemmed from several factors, including the collapse of the Somali state and political volatility in Ethiopia, cessation of overseas exports from southern Somalia, urban population growth, and a widening discrepancy between market prices in Kenya and in neighboring countries. Figure 2 shows increases in cattle sales/exports at two of Kenya's key border markets, namely Moyale (for the E/K trade) and Garissa (for the S/K trade). It should be noted that the Moyale market was closed for most of 1993-5 due to quarantine caused by Foot and Mouth Disease (FMD), which accounts for the minimal sales in those years. Nairobi is the destination for more than 75% of combined exports at the two markets.

Figure 2. Cattle Exports from Moyale and Garissa, Kenya, 1991-2001.



Source: Unpublished reports and data, Department of Livestock Prouction and District Veterinary Office Moyale and Garissa Districts, 1991-2002.

Both the S/K and E/K markets entail long-distance transport of cattle and involve a combination of trekking on foot and trucking. In the case of the E/K border trade, the length of trekking routes range up to 150-200 km and take on average about four to five days to cover. Once cattle are sold at Moyale, they are moved on trucks along very poor roads approximately 730 km to Nairobi, which takes another two days. By contrast, in the S/K trade treks to the border market (Garissa) can be as long as 400-600 km with an average period of nine to 10 days. The motorized segment of the route from Garissa to Nairobi traverses 420 km on a paved road and requires only about six hours. Because trekking animals "on foot" is relatively inexpensive, transport costs assume a higher percentage of total marketing costs in the E/K trade because of its reliance on motorized transport. Trucking can account for as much as 58 to 76% of marketing costs in the E/K trade, but only 34% in the S/K business.

Table 2. Ethnicity of traders[1] at the Moyale and Garissa border markets, Kenya.

Ethnicity	Moyale (%)	Garissa (%)
Somali (Including Garre)	8	92
Burji	50	--
Boran	22	--
Gabra	17	--
Other	3	8
Total	100	100

[1] N = 84 traders for Garissa and N = 62 traders for Moyale. Source: Little and Mahmoud (in press)

Important differences occur in the institutional, social, and procurement arrangements of the two markets. Both businesses involve dyadic (buyer-to-seller) markets—often with the use of brokers as intermediaries—rather than open auctions. However, unlike the E/K commerce where there is considerable ethnic and social heterogeneity, actors at all levels of the S/K market chain are predominantly Somali. Consequently, the institutional arrangements and risks associated with the markets vary notably. Table 2 compares the ethnicity of traders in the two markets and reveals wide discrepancies in the social composition of the trade. While Somali traders dominate the S/K market, the E/K trade entails several different groups with the Burji representing the largest percentage of traders. National politics in the region have sharpened ethnic divisions in social and economic life, and exclusionary practices keep members of certain groups from assuming key roles in the cross-border trade.

Examination of suppliers and other actors in the two border markets also reveal critical differences. Virtually all of the suppliers, trekkers, and brokers in the S/K trade are Somalis, while the majority of the suppliers in the E/K trade are Boran and trekkers can be Gabra, Boran, or Garre. Market brokers are usually Burji or Boran in the E/K borderlands and Somali in the S/K area. Although the Boran only represent 22% of traders who sell to Nairobi in the E/K market chain, they comprise more than 80% of those who sell to Moyale itself. Contrary to this, the Burji occupy minimal roles as suppliers to the Moyale market but are dominant in buying at Moyale and supplying the Nairobi market.

What do these social differences imply for the cross-border trade? As could be expected, Kenyan-based Somali traders are buying from Somali herders or middlemen in the S/K cross-border commerce and can draw heavily on social relations based on kinship, marriage, and clan affiliation to enforce market contracts. Kenyan-based Burji and other traders in the E/K market, however, are mainly buying from Boran or, in some cases, Gabra or Garre herders and traders with whom they have minimal social ties. Unlike the S/K commerce, there is a strong ethnic division between producers and traders in the E/K trade and buyers rarely have partnerships with neighboring suppliers/producers. In fact, because of local politics there often are strained relationships between the different groups in the E/K commerce and the dominant Kenyan-based trading group, the Burji, are especially vulnerable to political pressures because of their minority status in the area. They deal with their Ethiopian-based counterparts (often Boran) who supply the Moyale market on a strictly cash basis. In contrast, the majority of Kenyan-based traders in the S/K business have strong market relationships with middlemen and herders on the other side of the border and use these ties to procure animals for the Kenyan market. Thus,

Table 3. Occurence (%) of major problems associated with cross-border cattle trade.[1]

Problem	Somalia / Kenya Border Traders	Ethiopia / Kenya Border Traders
Insecurity	20.0	32.5
Transport- related	12.0	25.0
Pasture / Water	17.0	13.5
Market-related (low prices, excessive competition, etc.)	24.0	7.0
Animal Disease	6.0	0.0
Loan / Credit problems	7.0	12.5
Fees / taxes (incl. bribes)	4.0	9.5
Other	10.0	0.0
Total	100.0	100.0

[1] N = 84 for SK traders; 71 for E / K traders
Source: Little and Mahmoud (in press)

the supply chain in the S/K trade tends to involve more complex buyer/seller relationships than the Ethiopian commerce, and these are reinforced by trust relationships based on common ethnicity and clan affiliations.

The market risks associated with the S/K and E/K trade also reveal important and surprising differences (Table 3). When traders were asked to identify their major problems with the cross-border trade, insecurity showed up as a major concern in both markets, but for different reasons. It was identified as more of a problem in the E/K than the S/K commerce. In the S/K trade most risks occur between supply areas and the border market (Garissa), while in the E/K exchange they are concentrated between the border venue (Moyale) and terminal market (Nairobi) and not in the supply catchments. These risks include violence and theft along the Moyale/Isiolo road, cash losses at the Nairobi market, and insecurity on the trekking routes between the E/K border and Kenya's interior markets. Few traders in the S/K commerce identified either thefts or Nairobi-based credit fraud or violence en route to Nairobi as major problems.

Other important risk differences in the two markets center on transport, price/market issues, and credit. Not surprisingly, with the poorly maintained and lengthy road between Moyale and Nairobi, transport was more of a concern for E/K than S/K merchants. As for the market itself, S/K traders voiced greater concerns than their counterparts over excessive supply, low prices, and 'cut throat' competition. With the collapse of Somalia's state in 1991 and the subsequent loss of export and domestic markets in southern Somalia, there are few market opportunities other than Kenya for Somalia-based traders. As a result, there are numerous Somali traders seeking opportunities in the cross-border business, resulting in a competitive and occasionally 'oversupplied' market. Trade possibilities, in turn, are better in southern Ethiopia, where there is the option of selling on the Addis Ababa market or to a small, but growing, export trade.

Credit/loan problems are issues in both market chains, but assume greater magnitude in the E/K than S/K trade. Virtually all traders from northern and northeastern Kenya sell their animals on credit/consignment to the large meat wholesalers in Nairobi. Most of these meat businesses are owned by members of other ethnic groups, although there are a few owned by wealthy, urban-based Somali. While less than 5% of S/K traders experienced losses of cash to wholesalers through loan default, more than 25% of E/K traders had this happen to them. In a survey of 35 E/K traders in 2001-2002, the average amount of credit owed to them from Nairobi wholesalers was US $2,992, an exorbitant amount for the scale of their operations. Unlike S/K traders who have many personal and business contacts in Nairobi because of its sizable Somali population, E/K traders are from groups who are poorly represented in Nairobi and can draw on few enforcement mechanisms, including the legal system. Consequently, northern Kenyan merchants are easily exploited in Nairobi.

The institutional response to these risks in the E/K commerce has been the emergence of partnerships to facilitate the collection of Nairobi debts, the flow of market information between Nairobi and Moyale, and theft reduction along the Moyale-Nairobi road. Currently more than 90% percent of E/K traders are in partnerships with another trader, who is usually from the same ethnic group. One of the merchants stays in Moyale to buy Ethiopian animals and the other is based in Nairobi to sell and collect on payments. The Nairobi-based associate sells animals and relays market information back to Moyale via land-line telecommunications and, recently (2005) cell phones, as well as to collect on consigned animals. Without a person based in Nairobi, it is very difficult and expensive for a Moyale trader to wait around Nairobi to collect on debts. In other work, Mahmoud has shown that E/K traders with a partner in Nairobi have about a 60% less chance of experiencing credit/payment defaults than those without partners.

Importantly, the Nairobi partner also arranges for the cash to be transported back to Moyale, usually by selling it to a Moyale businessman who may be in Nairobi buying supplies to transport back to Moyale. A quick phone call to Moyale confirms the transaction and the Moyale-based partner collects the cash from the wholesaler's business at the border town. This financial innovation minimizes the risk of having cash stolen to/from Moyale and

Nairobi. Both the cattle trader and the Moyale-based wholesaler benefit from this arrangement, since the latter also does not have to travel with large amounts of money on the Moyale-Nairobi road.

With a different set of market risks, S/K traders build strong market relationships with suppliers based in southern Somalia rather than forge partnerships in Nairobi. In most cases these are not true partnerships as in the E/K example above, but an arrangement whereby the S/K trader regularly procures animals from one or more established middlemen and pays them a per animal fee or the market price when the animal is sold. In a few cases cash advances are made by the Kenyan-based businessman to facilitate procurement from Somalia. More than 80% of traders in the S/K commerce work under these institutional arrangements and usually deal with no more than two or three middlemen.

Cross-border trade assists Kenya in meeting its national demand for animal products, while providing incomes and livelihoods for thousands of neighboring herders and traders. As this paper has shown, the trade itself confronts a range of risks and problems and traders and herders have developed a range of institutional mechanisms to respond to these. Policies that might mitigate risks associated with the trade involve both regional and national actions. At the regional level, considerable progress has been made, especially between Ethiopia and Kenya, in forming local border committees that address critical issues like cross-border trade. Nonetheless, at national levels there is still a lack of understanding of the critical role the trade plays in meeting local and national beef demand and in raising local incomes and business activities. Additionally there is a failure by officials of member states to acknowledge cross-border trade as a form of international commerce that brings value added to exporting countries similar as happens in the overseas export trade. Because of this lack of recognition and adequate information, trans-border commerce often is still portrayed as smuggling and illegal and, consequently, remains subject to disruptive border closures and animal confiscations.

The lack of adequate public infrastructure and security limits the benefits of cross-border trade both to individual countries and to local producers and merchants. As we have shown, most of these markets entail long-distance transport across sparsely populated, dangerous areas and over poorly maintained roads. Improvements to roads and public safety and the legal prosecution of unscrupulous wholesalers and merchants would go a long way toward increasing the gains from cross-border trade.

Activity Three: Building Capacity within FERD at Egerton University

Problem Statement and Approach. The objective of this activity has been to build capacity within the Department of Natural Resources within the Faculty of Environmental Science and Resource Development (or FERD) at Egerton University in Kenya. Strengthening local universities is an important aspect of capacity building within the GL-CRSP. Our approach consists of providing research opportunities for FERD faculty and staff as well as giving attention to the other aspects of institution building. The latter is focused on creation of a small GIS teaching and research laboratory in the Department of Natural Resources. The main co-leaders for this activity in the past year have been Prof. Aboud and Dr. Layne Coppock.

Progress. In the past year three students have been in the training pipeline, all supervised by Prof. Abdillahi Aboud. First, Mr. Abdullahi Dima Jillo, a Ph.D. candidate in Human Ecology, has been analyzing his data from fieldwork on conflict among the Waso Boran of northern Kenya. Mr. Mark Mutinda, also a Ph.D. candidate in Human Ecology, has completed his fieldwork and commenced data analysis on the risk of losing key resources for pastoral and agropastoral divisions in Baringo District. Mr. Mutinda also received a Jim Ellis Mentorship Award in 2004 to conduct his research. Finally, Mr. Nicholas Olekaikai, an M.S. candidate in Human Ecology, has completed his field work examining risk of losing key resources for Marigat Division, also in Baringo. Work by Mutinda has a strong GIS component. Mutinda received special training in GIS technology in early 2003, and has become a prime force behind the creation of a 10-seat GIS

teaching lab, funded incrementally by PARIMA since the late 1990s.

The outputs remain on track for this activity. The written products in the past year have included two Research Briefs (Aboud et al., Jillo et al.) and three oral presentations or posters (Aboud, Jillo et al., Mutinda et al.). See Publications and Abstracts and Presentations for details. Below we provide highlights from aspects of recent research conducted by Prof. Aboud, Mr. P.K. Kisoyan, and A. Jillo.

Agro-Pastoralists' Wrath for the* Prosopis *Tree: The Case of the Il Chamus of Baringo District, Kenya. *Prosopis juliflora*, henceforth referred to here as *Prosopis*, is a moderately sized tree that also has a shrub-like form in some situations. It has root nodules that can absorb nitrogen from the atmosphere, and thus the species may supplement soil fertility in some instances. It has an extensive lateral root system that can help reduce soil erosion. It quickly establishes from seed and has a long taproot that enables the plant to access ground water deep below the surface when rainfall is scarce.

Prosopis was first introduced to eastern Africa in the 1970s through collaborative projects involving local governments and outside agencies. Initially, *Prosopis* was seen as an appropriate prescription for the environmental woes of dry lands. *Prosopis* could provide leafy fodder and pods for livestock feed, fuel wood, and erosion protection for denuded areas. *Prosopis*, however, reportedly had some negative attributes. It was known to be a strong competitor with other plants for soil moisture. More recent research suggests it may also exude toxins that inhibit growth of under-story vegetation.

Here we examine the attitudes of some local residents from Baringo District concerning their experience with the ecology and management of *Prosopis*. We compare and contrast these views with other information about the species from literature and expert opinion. Our data are based on 73 interviews conducted among the Il Chamus people, who tend to practice agro-pastoralism in Baringo District.

The Il Chamus we interviewed were very familiar with the botanical and ecological features of *Prosopis*. On the positive side, the respondents confirmed that *Prosopis* provides nutritious fodder for small stock, the nectar is useful for making a white honey, and the quality of wood products is high. The latter includes wood used for construction and household items. The quality of fuel wood is good. The plant has an excellent ability to re-grow after stems are cut and harvested, and this is referred to as coppicing.

Our respondents, however, were much more adamant about the negative aspects of *Prosopis*. Overall, they regarded the species as highly aggressive and invasive, forming impenetrable thickets that choke out other plants. When it occurs near watercourses, it can clog irrigation schemes. It is considered to be resilient and very regenerative, out-competing and eliminating other plants. It is actually thought to encourage erosion because the under-story of herbaceous plants can be eliminated; impacts on reducing biodiversity can be severe. By extensively drawing on ground water, dense stands of *Prosopis* are also thought to lower water tables. Although the seedpods are indeed palatable to livestock, the chemical content is thought to cause tooth problems for goats. A diet high in pods can reportedly cause mortality in sheep and goats due to digestive problems like impaction; even cattle can die if they feeds heavily on *Prosopis* leaves over a prolonged period of time—this is perceived to be due to toxicity. Finally, the pollen of *Prosopis* is speculated to cause human allergies, asthma, and lung inflammations.

Some of our results confirm earlier work in Baringo by Clement Lenachuru. He found that Il Chamus people he surveyed thought that *Prosopis* had proven to be the "worst enemy" of the local people over the past 20 years. The Il Chamus have now decided to "wage war" against *Prosopis*, calling for its complete and unconditional eradication. The Il Chamus have even threatened to take legal action against the Kenya Government for environmental damages caused by the tree.

The *Prosopis* dilemma in Baringo is only one example of the many problems brought about by the introduction of new species without proper scientific study concerning their long-term effects on the environment, preferred management, and optimal forms of utilization. Unfortunately, practical experiences from many parts of the world have now

shown that complete eradication of established *Prosopis* is virtually impossible. It is clear from our interviews that the species is considered a major threat to rural society by the Il Chamus.

There is a need to find ways of better utilizing and managing *Prosopis* in Baringo, with an eye towards controlling its spread. Successful interventions would require extensive collaboration among government and non-government groups. These efforts require a multi-pronged approach involving policy and technical aspects.

The scope for addressing *Prosopis* problems via government policies and legislation is vast. Local enforcement of regulations is also vital. The legality of introducing alien species should be addressed. The process of land adjudication and promotion of appropriate land use needs urgent attention. Improved management and control of *Prosopis* requires organized efforts in terms of public education and public awareness-raising. This includes promotion of how *Prosopis* products could be best harvested and used. In other developing countries economic value has been added to some types of *Prosopis* products, and this involves comprehensive efforts incorporating product certification and marketing. Success stories revolving around wood prominently include firewood, charcoal, building materials, floor tiles, furniture, and handicrafts. Other opportunities involving non-wood products include processing for livestock feed, human food (toasted seeds), possible medicinal values, gum production, and tannin extraction.

Thinking about how to engage communities and build capacity in a process of ecological restoration of *Prosopis*-affected sites also merits attention. There are situations where the ability of the species to add nitrogen to the soil and protect badly eroded sites against further ecological damage still matter. Mobilizing people to better deal with *Prosopis* is a large problem. It would require full appreciation of constraints and opportunities imposed by socio-economic features of local societies. These include attitudes and values with respect to community participation in resource management issues, problems that poverty imposes on people's priorities, conflicts in land use, land tenure, the role of rural insecurity in resource use, and constraints in the availability of labor. We also advocate that research is needed to assist this process. This could include policy analysis and studies devoted to verifying attributes of *Prosopis* noted in our interviews. There is also a need to carefully document success stories and constraints in the harvest, processing, and marketing of promising *Prosopis* products.

Degree of Sedentarization Affects Risks and Conflicts for the Waso Boran in Northern Kenya. The once productive rangelands of northern Kenya, traditionally dominated by a mix of woody species *(Acacia, Commiphora, Cordia spp.)* and graminoids *(Tetrapogon, Aristida, Chrysopogon and Sporobolus spp.)*, have gradually deteriorated in ecological condition over recent decades. A major factor blamed for this trend is the disintegration of traditional systems of land stewardship. Traditional authority has waned in northern Kenya and has often been replaced by open-access tenure that is overseen by ineffectual government administrators. Couple this with frequent droughts that typify this zone, as well as expanding populations of people and livestock, and the net result is increasing resource competition and conflicts. Local people throughout northern Kenya have reportedly entered a survival mode where the incidence of armed conflict has increased because resource-based disputes have intensified. An objective of this research was to investigate, quantify, and rank the views of the Waso Borana people, one of many ethnic groups in the northern Kenyan rangelands, concerning the risks they face and the causes and possible solutions to conflicts that revolve around natural resources.

Data reported here represent just one small portion of the information collected from a larger household survey conducted for doctoral research by A. D. Jillo among the Waso Borana. A questionnaire was administered to 540 households in Isiolo District during the past year, with the head of the household or his representative responding. The three lifestyles practiced among the Waso Boran in Isiolo District include sedentary, semi-sedentary, and fully mobile pastoralism. Sedentary means that the family members live in one place throughout the year, usually in proximity to a permanent village or town. The livestock of sedentary households may sometimes roam widely, but the animals tend

Table 4. Frequency of important risks perceived by household heads representing three types of pastoral lifestyles among the Waso Boran of Isiolo District, Kenya.[1]

Important Risks as Perceived by Household Heads	Types of Lifestyles							
	Sedentary Households		Semi-Sedentary Households		Mobile Households		Total Households	
	No.	%	No.	%	No.	%	No.	%
Drought	109	(28%)	58	(15%)	221	(57%)	388	(72%)
Grazing shortage	115	(30%)	62	(16%)	209	(54%)	386	(72%)
Water shortage	112	(29%)	58	(15%)	214	(56%)	384	(71%)
Insecurity	112	(30%)	60	(16%)	206	(54%)	378	(70%)
Food shortage	101	(27%)	59	(16%)	217	(57%)	377	(70%)
Resource-use conflict	106	(30%)	60	(17%)	188	(53%)	354	(66%)
Resource tenure problems	105	(44%)	75	(32%)	58	(24%)	238	(44%)
Human diseases	109	(49%)	54	(24%)	60	(27%)	223	(41%)
Poor market access	36	(22%)	60	(37%)	66	(41%)	162	(30%)
Livestock diseases	6	(16%)	2	(5%)	30	(79%)	38	(7%)

[1]*Entries are based on sample sizes that varied from 120 households (semi-sedentary), to 180 (sedentary), and 240 (mobile).*
Source: A.D. Jillo (in preparation).

to remain in the same general area all year. The semi-sedentary lifestyle means that both the family members and livestock can occasionally move during the year. This primarily occurs according to seasonal changes in availability of forage or water. The mobile lifestyle, in contrast, is when both people and livestock can opportunistically move all year as needed.

Our sample sizes for these three lifestyle groups varied from 120 (semi-sedentary) to 180 (sedentary) and 240 (mobile). Results documented here were obtained using open-ended questions as follow: (1) what risks do you encounter?; (2) what are the main causes of conflicts that you experience?; and (3) what solutions do you recommend to reduce these conflicts? Respondents provided as many answers as they could to each question.

The most common risks perceived by the respondents are shown in Table 4. Across all three types of lifestyles, the household heads were most concerned about drought and shortages of forage, water, and human food. Prevalence of resource-related conflict was also seen as a significant problem. In contrast, market access and livestock diseases were viewed as less important risks overall. There was important variation due to lifestyle, however. For example, the mobile households considered drought, shortage of grazing and water, insecurity, human food shortages, and resource-use conflicts as the most significant, while the sedentary and semi-sedentary households considered land-tenure problems, human diseases, and poor market access as more important (Table 4).

The most common perceived causes of resource-related conflicts are shown in Table 5. Across all three types of lifestyles the household heads most commonly mentioned basic ethnic differences, influx of weapons, and shortages of forage and water. At the bottom of the list were things like numbers of livestock and political incitement. Again, there was important variation due to lifestyle, however. For example, while encroachment of cultivation on seasonal grazing lands was considered as a very important cause of conflict for the semi-sedentary households, the sedentary households more commonly listed a broader array of causes, prominently including political incitement, inappropriate development interventions (such as establishment of permanent settlements and wildlife sanctuaries in dry-season grazing areas), encroachment of cultivation on

grazing lands, and new (competitive) forms of resource tenure. The political incitement factor was often reported by sedentary respondents for several reasons and we clarify these points here. The elites who incite political problems live in towns or villages. Political incitement occurs during election campaigns and ethnic, land-use, or development issues are commonly used as the "fuel for the fire." Sedentary pastoral households are accessible to such politicians and can be easily mobilized into violence. Sedentary pastoralists are also most vulnerable to loss of assets and livelihoods from political violence.

The mobile respondents prioritized shortages of water and forage, high livestock numbers, and other development interventions (such as boreholes in wet season grazing areas, lack of water use regulations for government-constructed water points, establishment of irrigation schemes and wildlife sanctuaries, and implementation of projects that restrict mobility such as grazing blocks that concentrate people and stock in small areas). In general, the semi-sedentary households were reportedly most able to evade conflicts based on water shortages, political incitement, etc., compared to the sedentary and mobile groups (Table 5). This is because the semi-sedentary households are better able to employ short, opportunistic movements of people and stock to less-risky situations.

The most commonly mentioned solutions to conflicts are shown in Table 6. Across all three lifestyles, the most common responses concerned control of weapons and enforcing ethnic boundaries, securing pastoral legal control over the rangelands, and improvement of water facilities. Again, there was important variation due to lifestyle, however. For example, the mobile pastoralists more clearly supported the ideas of having pastoral interests fully control the rangelands, enforcing ethnic boundaries, controlling the influx of weapons, and improving water facilities. The sedentary group, in contrast, strongly advocated stopping political incitement, with some attention to reducing livestock numbers and enforcing appropriate land tenure regimes. The semi-sedentary group considered reducing livestock numbers and enforcing ethnic boundaries as most important.

Table 5. Frequency of important causes of natural-resource related conflicts as perceived by household heads representing three types of pastoral lifestyles among the Waso Borana of Isiolo District, Kenya. See text for description of various causes of conflict.[1]

Important Causes of Conflicts as Perceived by Household Heads	Types of Livelihoods							
	Sedentary Households		Semi-Sedentary Households		Mobile Households		Total Households	
	No.	%	No.	%	No.	%	No.	%
Ethnic differences	162	(35%)	118	(26%)	178	(39%)	458	(85%)
Influx of weapons	173	(38%)	110	(24%)	175	(38%)	458	(85%)
Water shortage	157	(41%)	42	(11%)	187	(48%)	386	(72%)
Predatory wildlife	129	(33%)	102	(27%)	156	(40%)	387	(72%)
Shortage of grazing land	157	(44%)	43	(12%)	155	(44%)	355	(66%)
Resource tenure	108	(49%)	58	(26%)	55	(25%)	221	(51%)
Encroachment of Cultivation	70	(49%)	67	(47%)	6	(4%)	143	(27%)
Development interventions	79	(57%)	1	(<1%)	58	(42%)	138	(26%)
Livestock numbers	57	(55%)	7	(7%)	40	(38%)	104	(19%)
Political incitement	60	(90%)	0	(0%)	7	(10%)	67	(12%)

[1]*Entries are based on sample sizes that varied from 120 households (semi-sedentary), to 180 (sedentary), and 240 (mobile).*
Source: A.D. Jillo (in preparation).

Table 6. Ramked order of possible solutions to natural-resource related conflicts as perceived by household heads representing three types of pastoral lifestyles among the Waso Boran of Isiolo District, Kenya.[1]

Important Potential Solutions to Conflicts as Perceived by Household Heads	Types of Livelihoods							
	Sedentary Households		Semi-Sedentary Households		Mobile Households		Total Households	
	No.	%	No.	%	No.	%	No.	%
Control of weapons influx	174	(34%)	101	(20%)	233	(46%)	508	(94%)
Enforce ethnic boundaries	102	(20%)	167	(33%)	235	(47%)	504	(93%)
Pastoral land control	113	(28%)	76	(19%)	216	(53%)	405	(75%)
Improve water facilities	172	(42%)	51	(13%)	183	(45%)	406	(75%)
Enforce appropriate land tenure regulations	112	(49%)	53	(23%)	65	(28%)	230	(43%)
Control predatory wildlife and encroaching agriculture	91	(40%)	60	(27%)	74	(33%)	225	(42%)
Reduce livestock numbers	113	(51%)	76	(34%)	32	(15%)	221	(41%)
Stop political incitement	56	(95%)	1	(2%)	2	(3%)	59	(11%)

[1]*Entries are based on sample sizes that varied from 120 households (semi-sedentary), to 180 (sedentary), and 240 (mobile)*
Source: A.D. Jillo (in preparation)

Fear of violent conflict is reportedly pervasive in the Waso Borana region of northern Kenya. Although increased populations of people and livestock are likely to be the root causes of conflict related to scarcity of natural resources, the respondents tended to identify symptoms of over-population problems. There has been a systematic failure of government to provide choices and options for people who may desire to exit the pastoral sector, thereby releasing more resources to those that remain behind. Government has also failed to provide an environment secure from fear and violence, and a major dimension of this is a chaotic pattern of natural resource use and access that promotes insecurity. Until commitments are made by government to reduce conflict and restore confidence of local people in a predictable form of natural resource access and governance, technical intervention to enhance forage and water supplies, for example, will be irrelevant. Relief, rather than development, will continue to dominate the social agenda.

The control of weapons proliferation appears to be the most clearly defined short-term objective that would be helpful to achieve. Associated efforts by policy makers to protect the rights of local people with respect to land access and use are also vital. Some of the local problems in Isiolo District have international roots, however. Unrest within neighboring countries such as Ethiopia and Somalia occasionally spills over into northern Kenya, and weapons may originate from these sources. International coordination is therefore required in any long-term, viable solution to reduce crises in Isiolo District.

Finally, to be technically effective interventions to reduce conflict must be location and lifestyle-specific and address the diverse needs of each of the three groups described here. Blanket application of corrective measures may not be productive.

Activity Four: Project Regionalization: Dissemination of Information

Problem Statement and Approach. The information and experiences generated by the PARIMA project have broad applicability to the pastoral regions of eastern Africa and the Greater Horn. On a limited budget, our plan has been to achieve a regional impact of PARIMA via the dissemination of information, both via hard copy

mailings, distribution of CDs, and electronic dissemination. We also maintain web sites in the USA to make project-related materials available. The co-leaders of this activity are Drs. Solomon Desta, John McPeak, Layne Coppock, and Chris Barrett. Prof. Aboud, Mr. Seyoum Tezera, Dr. Getachew Gebru, and Mr. Dadi Amosha play supporting roles in the production and translation of PARIMA UPDATE. Most work occurs either at the Nairobi campus of ILRI or at Utah State University, Syracuse University, and Cornell University.

Progress. We continue to archive electronic versions of all publications generated by PARIMA. We continue to update our project websites at Utah State University and Cornell University. We are also updating the e-mail and mailing addresses for everyone on our regional list of network partners. The list now has over 200 entries. Over 300 sets of PARIMA Research Briefs were mailed out using our mailing list. Over 200 CDs containing electronic copies of most PARIMA publications have also been distributed in east Africa.

A new Memorandum of Understanding (MoU) was established between PARIMA and ILRI. The PARIMA project is now formally linked to ILRI Theme 2, "Enabling Innovations." Specifically, PARIMA has forged a closer relationship with the ASARECA Animal Agriculture Research Network/ Crisis Mitigation Office (A-AARNET/CMO) initiative, and this will allow PARIMA to gain access to a wider regional network for dissemination of PARIMA materials. A key contact in this regard is Dr. Jean Ndikumana of ILRI.

Activity Five: Outreach and Action Research

Problem Statement and Approach. Provision of supplemental funding to PARIMA from the USAID Mission to Ethiopia since 2000 has allowed us to engage more directly in problem solving concerning pastoral risk management, with a focus on the southern Ethiopian rangelands and adjacent borderlands of northern Kenya. Funds have been provided under the auspices of the Southern Tier Initiative (STI), and umbrella that includes GO and NGO entities involved in pastoral development on the Borana Plateau. The main objectives of this activity are to: (1) Build capacity among pastoralists, development agents, and policy makers to understand and implement pastoral risk management interventions; and (2) document best-bet community led projects using monitoring and evaluation protocols. Dissemination of information is an important part of outreach, and this is covered under Activity 4 (above). Knowledge, however, can also be generated as a result of applying Participatory Rural Appraisal (PRA) and Action Research (AR) in rural settings. This is distinct from traditional survey research methodologies. Both PRA and AR are methods of investigation whereby power is shared among researchers, pastoral communities, and development agents in the process of sustainable solving of local problems. The PRA process is a diagnostic tool to assist communities in identifying systemic problems and locally viable solutions. The AR is layered on during the monitoring and evaluation process after the PRA when pilot interventions have been implemented. The AR involves rapid problem diagnosis and intervention to alleviate constraints if and when community development processes are derailed. Pure outreach activity has been led by Mr. Seyoum Tezera, ably assisted by Mr. Dadhi Amosha. Action research has been guided by Dr. Solomon Desta, Dr. Layne Coppock, Dr. Getachew Gebru, and Mr. Seyoum Tezera. Other leadership for this component is being provided by partners representing the USAID Mission to Ethiopia as well as selected GOs and NGOs including Action For Development (AFD), Save the Children USA, the Oromia Cooperative Promotion Bureau (OCPB), and the Oromia Pastoral Development Commission (OPDC). Scientists from the Oromia Agricultural Research Institute (OARI) are also being gradually brought into the work in the past year.

We achieved more in this activity during the past year than originally planned. For capacity building, we sponsored or co-sponsored 17 events attended by over 2,500 people. These included short courses in savings and credit methods, small business development, cross-border linkages between Kenyans and Ethiopians, and exchange tours for pastoralists and policy makers (see Non-Degree Training). For monitoring and evaluation, the performance of 115

households was evaluated on a quarterly basis across 59 savings and credit groups in terms of measuring success of undertaking new micro-enterprise activities to diversify income. All loan recipients and participants in a non-formal education activity have been monitored for various performance milestones. Effects of cross-border women's tours on expansion of women's groups and spurring innovative behavior in Ethiopia were documented. All monitoring and evaluation is being conducted in partnership with GO and NGO organizations.

This activity has also generated six research-related products. They include one Research Brief (Desta et al.) and five oral or poster presentations (Desta and Gebru, Desta et al., Gebru, and two by Gebru et al.). See Publications and Abstracts and Presentations for details. An effort by Desta et al. is highlighted below.

Linking Pastoralists and Exporters in a Livestock Marketing Chain: Recent Experiences from Ethiopia. Traditionally, the Borana pastoralists of southern Ethiopia have strived to build-up their livestock herds. Livestock serve multiple purposes in Borana society, including milk production, meat production, a form of investment, and provide cultural values. Occasionally, cattle or small ruminants could be sold to buy food grain, clothing, and other commodities. The need to buy food is most apparent during dry periods when milk production from cows—the key component of human diets—is in decline. Accordingly, off-take rates for livestock have been low. The accumulated evidence suggests that the Boran in decades past have been very reluctant to engage in commercial livestock marketing, and for good reasons. Many social, economic, ecological, and policy factors have been cited as contributing to this behavior. As human populations grow in rangeland areas, however, others have suggested that pastoralists like the Boran will be forced to engage in more commercial livestock activity simply to increase human carrying capacity—exchanging animals for more calories as grain could be one means to this end. Human population pressure and a declining per capita supply of milk (because herds cannot grow beyond ecological limits) is also postulated to encourage more grain cultivation and spur an increasing interest in the diversification of livestock holdings.

Table 7. Volume (MT) of small ruminant meat exports from Ethiopia, 1993-2004.[1]

Year	Small Ruminant Meat Exports		
	Mutton, Lamb	Goat Meat	Total
1993	33	0	33
1994	124	69	193
1995	259	243	502
1996	259	243	502
1997	312	1,490	1,802
1998	155	2,302	2,457
1999	87	1,818	1,905
2000	13	1,149	1,162
2001	20	222	242
2002	184	879	1,063
2003	1,501	2,094	3,595
2004	354	6,024	6,378
Avg.	**275**	**1,378**	**1,653**

[1] *Data for 1993-2003 are from FAO statistics. Data for 2004 are unpublished statistics from the Ethiopian Livestock and Fisheries Marketing Department.*

In the last few years several factors have altered the livestock marketing landscape in Ethiopia. There has been considerable development in the private livestock export industry. There has also been a growing demand for livestock products from Middle East and Gulf State nations. Evidence for this trend is especially evident for goat meat (Table 7).

Starting in 2000, the outreach arm of the PARIMA project in Ethiopia started to use participatory methods and strategic injection of development funds to identify sustainable, community-based interventions to improve pastoral risk management and mitigate poverty. Several years have been invested in the careful training and mentoring of 59 pastoral community groups, founded on concepts of non-formal education, micro-finance, and micro-enterprise development.

As an outcome of these efforts, pastoral groups soon expressed an interest in livestock marketing. The PARIMA project, in partnership with communities and a variety of governmental and non-governmental agencies, embarked on a process to help build a new livestock marketing chain starting from the southern rangelands that would take advantage of national and international opportunities mentioned above.

Leaders of pastoral groups, policy makers, and leaders of the livestock export industry were thus linked together in a series of exchange tours, workshops, and seminars starting in 2003. The exchange tours allowed pastoral leaders to learn about the size and quality (health) requirements for a new export market involving small ruminants. They also learned about what an export marketing chain entails. Policy makers and leaders of export firms also learned about the pastoral production potential of the rangeland areas. Initial purchase agreements were forged among buyers and sellers, and four exporting firms quickly began to operate in the southern rangelands. One key constraint discovered early on was a lack of capital for pastoral groups to procure small ruminants to sell to the exporters. Therefore, the African Union/Inter-African Bureau for Animal Resources (AU/IBAR) provided a total of USD 36,000 in interest-free loans to 10 of the pastoral groups and one new pastoral livestock marketing cooperative as test cases.

Here we report preliminary results of these aggregated activities, summarized more fully elsewhere. Overall, the core concept is human capacity building. Four years ago members of our pastoral groups had little or no rudimentary reading ability, could not do simple arithmetic, had no training in managing grass-roots savings and credit

Table 8. Summary statistics for small ruminant marketing by pastoralists as performed by 10 savings and credit groups and one cooperative in the southern Ethiopian rangelands for 2004-5.[1]

Project	Number of Members	Amount of loan[2] (Birr)	Head Sold by March 2005	Purchasing Enterprise	Profit Obtained (Birr)[3]	Month Activity Started
Groups A-E[4]	107	172,500	1,247	LUNA	NA[5]	October 2003
Group F	36	23,000	500	ELFORA	3,000	March 2004
Group G	35	23,000	3,761	LUNA	3,000	February 2004
Group H	20	23,000	931	LUNA	NA[5]	February 2004
Group I	36	23,000	4,631	ELFORA	8,900	February 2004
Group J	20	23,000	2,360	ELFORA	6,500	February 2004
Cooperative	40	23,000	12,210	LUNA	10,000	September 2003
Total	**289**	**310,500**	**25,640**	**---**	**---**	**---**

[1]Names of groups and the cooperative have been withheld to promote confidentiality.
[2]Loans from AU-IBAR are interest-free and used to establish revolving funds. The exchange rate is 8.65 Ethiopian Birr per US dollar.
[3]Figures are only estimates because written records are probably incomplete. Some groups were also reluctant to provide exact figures. Loans have not yet been repaid. Marketing activity is on-going.
[4]Five groups merged activities at one site.
[5]Figures unavailable.

operations, and had no formal knowledge of how to run a small business. We wanted to document what would happen after these pieces of the puzzle were put together. It was fortuitous that the training of pastoral groups coincided with major change and development in the Ethiopian livestock export industry.

Once things were set in motion, it did not take long for the market supply of small ruminants to dramatically surge in response to high export demand. For example, over 25,000 sheep and goats were sold by the 11 pastoral groups over 18 months to two of the exporters (Table 8). The marketing activity is ongoing and the AU/IBAR loans are still in the process of being repaid. Three of the groups managed by women have been among the top performers overall. The cooperative has been the outstanding performer in terms of sales volume and profit, but the cooperative has had the longest period of marketing activity. Trading was a major factor in animal accumulation by the groups when compared to animal holdings. These pastoral households actually didn't own many sheep and goats themselves, as they tended to be poorer than average. The pastoral groups therefore searched extensively for suitable stock to sell to the exporters. Animals were collected from across the Borana Plateau and Guji lowlands in Ethiopia. They were also collected from deep into northern Kenya. We have estimated the size of the catchment overall to be at least 57,000 km^2.

The supply provided by the 11 pastoral marketing groups is only part of a larger picture for southern Ethiopia during the observation period. Statistics from the export firm called LUNA illustrate the situation—LUNA exported 49,800 dressed carcasses in 2003, growing to 241,209 dressed carcasses for 2004 and another 77,662 for the first quarter of 2005. The grand total for 27 months was 368,671 dressed carcasses. Importantly, from 85-90% of this supply was collected from the Borana Plateau, Guji lowlands, and northern Kenya. Prices in various markets in the area rose from Ethiopian Birr 3.50 to 5.50/kg live weight during this purchasing period. Buyers eventually collaborated and limited buying prices to Birr 4.00-4.50/kg live weight.

This large surge in marketed supply was also unusual in that the flow of stock headed northwards. Traditionally, Nairobi has been the southern destination for cattle, and to lesser extent small ruminants, from southern Ethiopia. This observation of a northward market flow indicates that new market chains can form quickly under the right conditions. It has also been thought that the new flow of animals northwards must simply be subtracted from those that used to head south, and thus the overall market supply of animals has not increased. We recently interviewed traders at Kariobangi market in Nairobi to initially address this issue. The traders generally felt that the small ruminant market in the region was expanding; the new chain in Ethiopia was not thought to be affecting supply to Nairobi. In addition, the new export market for Ethiopia is demanding smaller, younger stock compared to that for Kenyan markets.

Despite successes achieved in building the new marketing chain, there have been some significant problems. The problems have mostly occurred in the local transfers of animals and money between pastoral producers and field agents who buy stock for the exporters. Failures of local transactions undermine trust on both sides. More problems seem to occur when flocks collected by pastoral groups are not picked up on time by the buyers and this can contribute to animal deaths and losses of condition. Delays in processing payments through local banks have occurred. Buying price can suddenly drop, turning profit into loss. In some cases local traders have disrupted marketing activity by newly formed pastoral groups. Other blockages have occurred when animals procured in Kenya were intercepted at the border and prohibited from entering into Ethiopia. The risks of marketing for pastoral groups are therefore high, and our groups have learned many valuable, but painful, lessons. Contracts are being developed between pastoral groups and buyers to help alleviate such problems. The process requires continual surveillance and pastoral groups still need mentoring. Conditions are now being created where market information and animal quality have heightened value. This can open the door for the application of new technology related to market information and animal heath.

Helping pastoralists enter a new marketing

chain is difficult and time-consuming. It requires perseverance, planning, and provision of long-term, high-quality technical support. Many pastoralists have deep-rooted suspicions towards outsiders and this inhibits formation of marketing partnerships. Some long-standing negative attitudes among livestock buyers towards pastoral areas and pastoralists are other hurdles to be overcome.

The results observed so far from this initiative with small ruminants have been encouraging. Pastoral marketing groups have responded to increased market demand for small ruminants. A new market chain has been created. Opportunities for income generation have spread in southern Ethiopia, and this prominently includes women as beneficiaries. Efforts to build human capital through education and mentoring are vital. Connecting buyers and sellers in forums to build trust and provide information to reduce market risks is fruitful, but contracts with legal protections for all parties are needed. Encouraging stakeholders to fully participate from the start enhances empowerment and shared ownership of a process.

The livestock export industry should help reduce business risks for pastoral producers, at least initially. Windows may be opening for information technology and animal health interventions to suddenly have greater applicability and value in the eyes of pastoral producers; more investment in these areas is essential. There is also a need to liberalize cross-border livestock trade and the movement of people between southern Ethiopia and northern Kenya. This would allow for more opportunistic market participation. Graduation of pastoral community groups into legally recognized cooperatives, and later scaling these up into cooperative unions, is essential to gain bargaining power for pastoral livestock suppliers.

Activity Six: Sustainable Engagement with Policy Makers

Problem Statement and Approach. Policy decisions often have large ramifications for pastoral people in Kenya and Ethiopia. The voice of pastoral people, however, is usually not heard in policy deliberations. The PARIMA project has gradually engaged policy makers over the past few years through the dissemination of written information as well as via field tours and workshops.

The PARIMA project began a process of directly engaging policy makers as a result of meetings convened in Nairobi and Addis Ababa during August 2003. Work during the past year has been a low-level continuation of efforts begun in 2003-04 that has focused mostly on the dissemination of project information (see Activity 4 above). In addition, we work to build bridges and affect policy-related thought through formal and informal engagement, either in the context of small meetings or one-on-one contacts. The goal is to better-inform decision makers with respect to pastoral issues, and in turn better-inform PARIMA as to what issues decision makers see as their most important needs to enable more effective decision-making. This involves a prolonged effort.

The co-leaders for this activity in the past year have been Drs. Getachew Gebru, Solomon Desta, and Layne Coppock and Prof. A. Aboud. The location of work will be broad within our host countries, including rural areas in northern Kenya and southern Ethiopia as well as efforts in the capital cities of Nairobi and Addis Ababa. On-going efforts by Drs. Chris Barrett and Peter Little to engage multi-lateral institutions, such as the World Bank, or at USAID Missions, are also very important to this end.

Progress. We tend to make more inroads with policy makers in Ethiopia compared to those in Kenya. This is because of our large outreach activity in Ethiopia co-sponsored by the USAID Mission in Addis Ababa and the professional and personal linkages between Ethiopian officials and PARIMA staff such as Dr. Getachew Gebru, Dr. Solomon Desta, Mr. Seyoum Tezera, and Mr. Dadi Amosha. Kenyan policy makers are less accessible to PARIMA than those in Ethiopia. Kenya has embarked, however, on producing a new policy and comprehensive document relevant to Kenyan pastoral lands. There is considerable dialogue occurring within the new NARC government in Kenya concerning pastoral lands, as well as optimism that investments in infrastructure for pastoral areas

will occur (such as with the Isiolo/Moyale road that cuts through our study area). A wide variety of special interest and advocacy groups engage the Kenyan government with respect to pastoral development. The comparative advantage of PARIMA in affecting pastoral policy debate has thus been lower in Kenya compared to that for Ethiopia, where the number of advocacy groups is much lower. PARIMA has several outputs this past year, however, that relate to policy matters. Some details follow.

A draft research brief by Aboud et al. concerning the proliferation of the woody weed *Prosopis* in Baringo District, Kenya, has policy relevance. *Prosopis* was initially brought to Kenya by outside experts hoping to boost wood production and soil retention in dry lands, but the species has aggressively taken over many areas in the past 20 years. See material under Activity 3 above.

One policy-related achievement in Ethiopia has been the recent role of PARIMA in promoting liberalization of official attitudes towards reinstatement of prescribed fire for rangeland management on the Borana Plateau. What had been previously thought to be "official policy" in the form of bans prohibiting local use of fire since the 1970s was actually just an assortment of "unofficial attitudes" of certain decision makers. There have been recent official pronouncements in the Regional State if Oromia clarifying the policy situation and allowing pastoralists to engage in prescribed burning. This has largely been a result of momentum and publicity associated with a PARIMA-sponsored fire course in February 2005. This is reviewed in an article by LaMalfa and Coppock (see Publications).

Other incremental progress has been made in Ethiopia in terms of involving policy makers in pastoral livestock marketing debates and creation of livestock marketing chains (see the summary of the Desta et al. Research Brief under Activity 5 above.) The outreach unit successfully took five policy makers on a tour of the southern Ethiopian rangelands in August 2005 (see Non-Degree Training). Finally, dozens of copies of PARIMA Research Briefs were distributed to parliamentarians in both countries who affect pastoral policy.

Activity Seven: Building Capacity of KARI and OARI in Pastoral Research

Problem Statement and Approach. One of the important aspects of the GL-CRSP is to build capacity among national research organizations, and that is the main objective of this activity. We have already been contributing to this goal on PARIMA by offering formal degree-training opportunities for Kenyans and Ethiopians at the MS, PhD, and post-doctoral levels. We see other opportunities, however, to build capacity among rank-and-file researchers at the Kenya Agricultural Research Institute (KARI—Marsabit, or otherwise known as the National Arid Lands Research Center) and the recently created Oromia Agricultural Research Institute (OARI—Yabelo). To this end we have started a process of linking KARI—Marsabit with OARI—Yabelo to begin a process of cross-border research, training, and collaboration.

Progress. Overall, this activity produced four research-related outputs including one Research Brief (Keya et al.) and three oral presentations and posters (Hussen, Keya, and Keya et al.) at the International Grasslands Congress in Dublin. The co-leaders of this activity include Drs. Solomon Desta, Getachew Gebru, George Keya, and Lemma Gizachew and Mr. Aliye Hussen. Dr. Layne Coppock provides guidance as needed. The specific training events for the past year are described in detail below, and are also enumerated in the section on Non-Degree Training:

1. Build capacity in Geographical Information Systems (GIS) with applications in identifying key ecological resources at risk in pastoral production systems. To this end we conducted a short-course in digitizing that was a follow-up to purchase of hardware and software and initial training in 2004. This course was conducted by staff from KARI HQ and was held at KARI/NALRC—Marsabit during May. Eleven research staff from OARI and KARI attended;
2. Build capacity in use of participatory research methods. Two short-courses were delivered by PARIMA staff and collaborators

to participants at OARI-Yabelo and KARI/NALRC—Marsabit during October and April, respectively. A total of 24 research staff participated;

3. Build capacity in use of prescribed fire in range management on the Borana Plateau. This involved a short-course designed and taught by the PARIMA team during February that incorporated lecture and field exercises including several prescribed burns. Material included fire ecology theory, policy implications, and techniques for fire monitoring and evaluation. Twenty-eight people attended this course; and
4. Build capacity in fundamental research skills among front-line staff. Most of the front-line research staff at KARI/NALRC-Marsabit and OARI-Yabelo lack post-graduate training. To address this issue we have embarked on supporting selected degree-training activities at local institutions that can be co-funded with national organizations. In the past year two master's candidates from OARI-Yabelo have been matriculated in the Dept. of Range Management at Alemaya University, Harar, Ethiopia. Mr. Sintayehu Mesele has prepared a draft research proposal dealing with soil characterization in relation to land use on the Borana Plateau. Mr. Getachew Haile has prepared a draft research proposal dealing with the characterization of land-use and land-cover dynamics using GIS technology. Upon completing proposal revisions, the students plan to conduct their field work in the coming year.

Insecurity along the Ethio-Kenya border necessitated, however, that we cancel two vital activities for KARI and OARI scheduled for May 2005. One was a short-course in social science research methods and database management. The other was a meeting to begin a joint cross-border collaborative research project. Both of these events have been rescheduled for 2005-06.

A couple other aspects of non-degree training deserve mention here under this activity. First, Mr. Eric LaMalfa, instructor of the fire course, is a master's student at Utah State University in the College of Natural Resources. The experience of developing and teaching the course clearly constitutes a non-degree training experience for himself as well as the 28 students who participated. Second, PARIMA became involved in facilitation of "senior thesis" experiences for several students from Debub University and Mekele University in Ethiopia. Students received partial support from PARIMA to conduct small field studies over a couple months duration in the Yabelo area. Students were housed at the OARI-Yabelo complex. The four students are listed in the section on Degree Training.

Below is a summary of a recent Research Brief. The co-authors are G. Keya, M. Ngutu, A. Adongo, and I. Tura. They are staff members of the KARI National Arid Lands Research Center at Marsabit, Kenya.

Bridging the Gap between Agricultural Technology Development and Adoption in Northern Kenya. The challenge of improving technology adoption by farmers and pastoralists in Africa is immense. It is an important issue in the international donor community as well as developing country governments that must justify large investments in research. Likewise, national research institutions like KARI are coming under increasing pressure to achieve tangible impacts in the form of deliverables that enhance the productivity and welfare of rural producers and hence help justify research investments. The problem is therefore one of creating impact. In the arid areas where alternative livelihood options for local communities are limited, the technical and logistical constraints are formidable. Donors have queried research investments in these areas, in particular. Efforts to improve productivity are often hampered by the low adoption rates of technologies. This is linked to—among other factors—non-participation of stakeholders in the research process, weak linkages between research and extension, and lack of access to suitable technologies in risk-prone environments. Some of the factors that limit the access of rural producers to technology include poverty, inadequate information, illiteracy, and the high cost and high risks of technology implementation.

From 1998, KARI, through its National Arid

Table 9. Profile of five groups supported through the Agricultural Technology and Information Response Initiative (ATIRI) in northern Kenya.

Group	Men	Women	Total	Objectives	Activities
Malakino	0	21	21	Integrate small-scale farming with income diversification and improve human nutrition	Tree nurseries and horticulture
Goro Ruksha	0	38	38	Increase productivity of small farms via use of labor-saving technology	Farming and Water harvesting
Songa	9	6	15	Increase milk production, enhance nutrient cycling, and increase incomes	Zero grazing
Mwangaza	0	26	26	Diversify income and improve food security	Loan scheme and drip irrigation
Robaf Nage	0	22	22	Income generation	Poultry keeping
Total	**9**	**113**	**122**		

Source: Kenya et al. (in press)

Lands Research Centre, initiated and tested new research approaches with the aim of improving acceptability and use of agricultural technologies among pastoralists and agro-pastoralists of northern Kenya. These approaches were implemented within the framework of the European Union supported Agricultural/Livestock Support Programme and the World Bank supported Agricultural Technology and Information Response Initiative (ATIRI). Intervention areas included natural resource management, improved crop production through water harvesting, livestock husbandry and health, and development and marketing of livestock products. Work was conducted in the Marsabit, Samburu, Turkana, Moyale, and Wajir Districts of northern Kenya. These are predominantly arid areas with a few arable sites. Here we summarize some of our experiences and lessons learned.

The diagnostic and constraint identification phase of the research cycle included participatory methods, rapid rural appraisals, and detailed exploratory and diagnostic surveys where 5,000 pastoralists and agro-pastoralists from 38 target areas throughout the region were involved in rigorous "self-evaluation" exercises. Identification, development, testing, and dissemination of technologies aimed at solving identified production constraints was carried out on site using Farming Systems Research (FSR) and Participatory Learning and Action Research (PLAR) approaches. Some of the tools used included community-based planning workshops, feedback workshops, and participatory monitoring. Producers were included in the research planning process and invited to participate in institutional workshops and research advisory committee meetings, both at the local (NALRC) and national levels. Capacity building involved providing adult literacy classes for participating groups, technical training and demonstrations, and exposure of producers to novel concepts and practices through study tours. Participants were debriefed immediately after the tours through discussions on what had been learned and the actions they planned to take.

The process of catalyzing technology adoption involved empowering producers to access technologies through ATIRI. In this approach producers began the process by submitting competitive proposals to KARI. The proposals were evaluated for their merit and once approved, seed funds were allocated to participating Community Based Organizations (CBOs) to access demanded technologies. The scientists and other subject-matter specialists from select government line ministries and non-governmental organizations provided the necessary

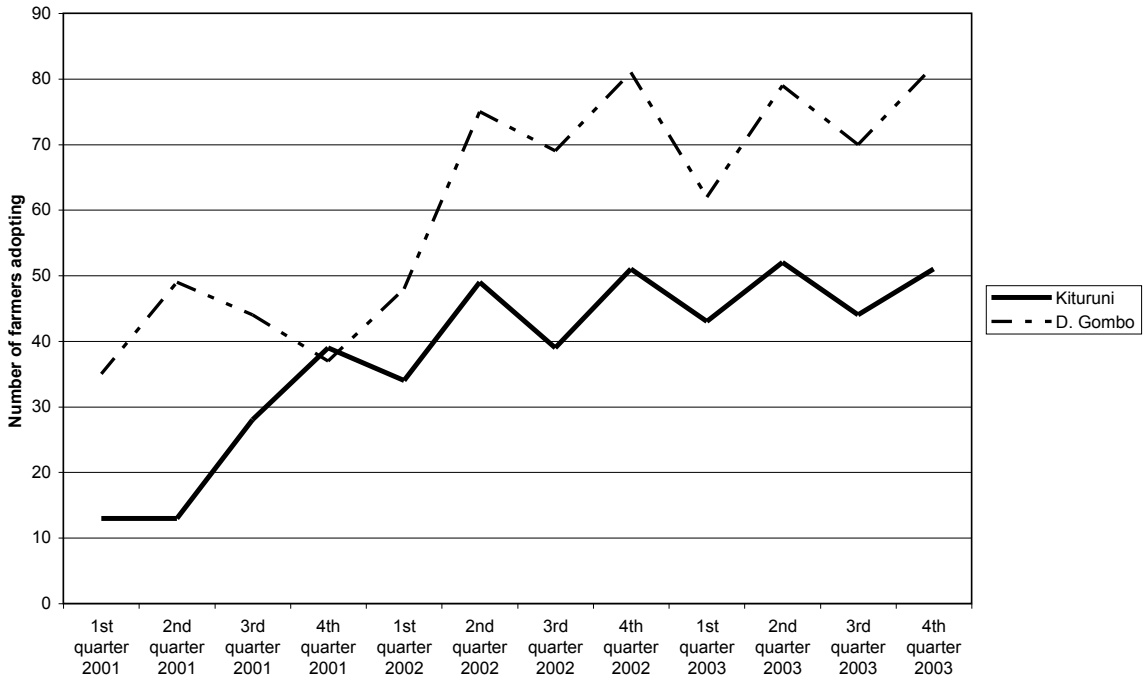
backstopping. The first phase of ATIRI support commenced in July, 2002, and was implemented through December, 2003. Table 9 shows a sample of groups that benefited from ATIRI support during this period.

To promote a sustained process, partnerships were developed with relevant and willing stakeholders underpinned by clear Memoranda of Understanding (MoU). There were several purposes for developing partnerships: (1) Mobilize communities where the presence of a development partner was strong; (2) more efficiently utilize financial and human resources from partners to support activities of common interest to achieve greater impact; (3) increase outreach coverage in areas far removed from KARI's main circuit of operations, but where collaborating partners had activities and strong presence on the ground to ensure greater potential for up-scaling of successful technologies and management practices.

Using participatory rural appraisal tools, it was possible to elucidate gender roles with regard to various activities at the household level and therefore appropriately target the participants for different types of interventions. For example, where it was learned that women and children are the managers of goats and sheep, then these groups were targeted with small-stock interventions. In cases where milk technologies are concerned, women were targeted since they are the group that has primary access and control over dairy resources.

Local dissemination of research results was achieved through field days and agricultural shows. The major intervention areas included natural resource management, improved crop production through water harvesting technologies, livestock husbandry and health, and development and marketing of livestock products. During these events producers participating in different research activities were taken as resource persons to demonstrate and explain various technologies and management practices. In this way these "adopters" felt more appreciated and this increased their motivation. Overall, compared to the staff of government agencies or NGOs, the innovative producers were the superior facilitators of change within their peer groups. The main benefit of this new approach was the increase in the number of pastoralists, agro-pastoralists, and farmers adopting technologies and improved management practices and an increased awareness by rural people as to the importance of

Figure 3. Adoption of water harvesting and water saving technologies by small farmers around Marsabit Mountain, 2-1-2003.



research and how research results can positively affect their daily lives. This was demonstrated by the relatively high adoption rates reported from among the different projects being implemented. For example, 100% adoption rates were recorded within three years for the following activities among target populations of several hundred people: (1) Demarcation of protected tree-recruitment sites using red paint; (2) water harvesting and water saving technologies; and (3) use of movable housing for young livestock. Figure 3 depicts the adoption pattern for water harvesting and water-saving technologies over three years.

The process of catalyzing adoption has also been employed with various forms of producer groups. Three mini-dairies have been established. These mini-dairies have been managed by people trained in the management of micro-enterprises and group dynamics. Reliable markets have been established for about 400 producers who supply raw milk to dairy collection centers and this has resulted in higher household incomes. In wet seasons milk prices have stabilized at higher levels than were previously offered by brokers. Improved milk handling, processing, and marketing has reduced rates of milk spoilage. The dairies have created direct employment for about 10 non-group members with a total monthly income of over USD $200. This income supports more than 60 other relatives. Partnership with a collaborating local NGO resulted in the building of three additional small-scale milk-processing units. Through capacity building, formally illiterate people are now maintaining records of their sales transactions. This has increased their understanding of technology and has enhanced their decision-making processes. Training and demonstrations have assisted groups to take better charge of activities themselves.

It has also been noted that the new approaches have some negative attributes. These include difficulties in the verification of impact from technology tested with "on-farm trials" because strict compliance of participants with agreed experimental protocols could not be guaranteed. Issues related to education level and cultural beliefs also hampered full participation by some community members. The Rendille community, for example, restricted women from participating in some community gatherings related to our work, meaning that female perspectives were not readily accessible. Some of our scientists have proposed that a mixture of participatory and formal research methodology needs to be employed to ensure that strengths of each are achieved.

To better bridge the gap between research and development, and to enhance the ability of producers to adopt beneficial research technologies, the agenda of the NALRC of KARI has embraced stakeholder participation, capacity building, development of partnerships, catalyzing adoption processes, increased effort to locally disseminate research results, and gender mainstreaming. These tenets should be institutionalized if research in Africa is to be seen as an engine of development.

Activity Eight: Jim Ellis Mentorship Program for Graduate Students

Problem Statement and Approach. The PARIMA project has two recipients of a Jim Ellis Mentorship award who are conducting research in progress. Mr. Mark Mutinda of the Department of Natural Resources at Egerton University in Kenya won an award for 2004. His dissertation topic deals with risks to key resources in Baringo District, Kenya. Mr. Dejene Debsu Negassa of the Department of Anthropology at the University of Kentucky won an award in 2005. His dissertation topic deals with land tenure and conflict dynamics among the Guji agropastoralists in southern Ethiopia.

Key resources occur in arid or semi-arid lands and are typically relatively small patches of seasonal grazing or water access that support entire livestock production systems. When these are lost production systems may be critically undermined. An early-warning system is needed whereby key resources at risk can be identified and protected. The Baringo District of north-central Kenya has endured decades of resource abuse and high rates of population growth—breakdowns of traditional systems have occurred and food relief is common. Despite this situation, most production system research in the past has been conducted at local scales of resolution. The advent of Geographic Information Systems (GIS) technology, however, allows investigations to scale-up. Precise mapping of resource problems

is now possible, and such maps can provide useful communication tools to better address issues. We have undertaken a hierarchical approach that focuses on the district, divisions, localities and communities. At the largest spatial scales we rely on social science methods to assess perceived key resources at risk according to community leaders, while at smaller scales we use ecological methods to verify and quantify resource vulnerability. This project has utilized new GIS analytical capacity at Egerton that has been initiated by the PARIMA project. We hypothesized that key rangeland resources in Baringo continue to be lost through annexation, degradation, and ethnic conflicts. The first phase of research relied on 136 regional leaders as key informants selected from across seven administrative divisions, with four from drier pastoral zones and three from agro-pastoral zones. People were asked to rank key resources at risk. The second phase of research deals with focus groups at a more local scale of resolution. The third phase deals with ecological characterization of randomly selected sites in terms of rangeland condition, trend, and loss of livestock carrying capacity. Mr. Mark Mutinda, a lecturer at Egerton University, is conducting this work for his doctoral research. His advisor is Prof. Abdillahi Aboud. Dr. Layne Coppock has provided guidance as needed.

The study of land tenure systems is important in the context of risk management. Land is a focal point of competing interests, an arena where political, legal, and cultural power interacts. In Ethiopia, for example, local, regional, and national forces have all expanded state control into pastoral areas. Indigenous pastoral institutions have been altered and herders have been alienated from their traditional base of natural resources. One outcome of these pressures has been increased sedentarization and reduced mobility for pastoral herds. Mr. Dejene Debsu Negassa will examine such changes among the Guji Oromo of southern Ethiopia. The main focus will be on how differentiation of wealth and interests among various stakeholders affects access and control of local resources. The research will also explore how the rules governing common property in the Guji Oromo area have changed over time. Conflicts between the Guji and neighboring Gedeo ethnic group will be studied and links to resource competition evaluated.

Progress. The past year has been a period of data analysis for the key resource study and a period of preliminary data collection for the land tenure and conflict study. In the coming year Mark Mutinda will finalize his dissertation at Egerton University, and final results will be available for the next GL-CRSP Annual Report. In the coming year Mr. Negassa will finalize his field data collection and return to the University of Kentucky to begin a phase of data analysis.

Gender

Gender dimensions of our project are reflected in terms of: (1) Team organization; (2) research issues being pursued; (3) training; and (4) aspects of outreach emphasis. For example, we have one economist on our core team with significant experience working on WID (Women In Development) issues in agricultural production systems and who has published in this area. We also have an anthropologist, other economists, and even an ecologist with extensive background collecting and analyzing sex-disaggregated data on pastoral household production systems. They have all published on topics related to the differential impact of risk management strategies on men and women. We have employed several female enumerators for research and women also serve our outreach activities in southern Ethiopia as teachers in a non-formal education program and as mentors in cross-border, community risk-management activities. Several women represent our national partner institutions, prominently including agencies in the Ethiopian regional state of Oromia.

We are carrying out a range of surveys in which data are collected from both men and women among both pastoral communities and among female-headed households in settled communities to describe and identify the influence of gender on household risk-management strategies (see Research Activities 1 and 2 above). Previous research has shown that the separate domains of men's and women's decision-making about income-generating

strategies can be at odds in ways that may be exacerbated by development interventions targeting one production strategy over another. The research results being produced can be used by USAID to better identify and address gender inequalities.

Finally, in studying the area we have determined that females are under-represented in terms of relative access to formal education and exposure to micro-enterprise concepts. We are seeking to redress these issues through Research Activity 5 whereby females continue to be a focal point for recruitment in short-courses, workshops, and informal education programs. These activities are supported by the USAID Mission to Ethiopia, but researchers are monitoring activities and documenting impacts of training and outreach.

Policy

Our main goal regarding policy is to have a positive influence on decisions that affect pastoral peoples in Kenya and Ethiopia. We want to achieve this goal primarily through engagement and education of decision makers. We have developed an extensive network for distribution of PARIMA Research Briefs and the PARIMA UPDATE newsletter (see Research Activity 4 above). We will continue to invite decision makers to attend meetings, workshops, field tours, and training opportunities. We have also used the PARIMA Research Briefs to give policy makers a forum to express their observations and views (see Research Activity 6 above).

Outreach

The Outreach Unit of the PARIMA project has been previously introduced in the 2000 Annual Report. Outreach funding has been provided from the USAID Mission to Ethiopia. Current outreach activities have been reported under Research Activity 5. The objectives of PARIMA Outreach are to build awareness and capacity of front-line development personnel and pastoral communities to better understand the utility of risk-management interventions and identify best-bet approaches to improve pastoral risk management based on results from pilot interventions and associated research.

Developmental Impact

Environmental impact and relevance. The benefits of our project to the environment are indirect rather than direct, and medium- and longer-term rather than short-term. Our basic position is that improved risk management will mitigate asset loss and poverty among pastoralists and agro-pastoralists. When poverty is mitigated risk to the environment will lessen. For example, one tenet of our approach is that pastoralists need to make more pre-emptive moves to mitigate crisis induced by drought and growing human populations. One tactic is to sell some animals before a crisis occurs, and use the funds received as household-level savings and community investments. The success of this depends on well-functioning markets, credit union formation, education, etc. The idea is that if such a tactic can be successfully used across a society, the rate of growth in stocking rates would be mitigated. This would reduce the specter of heavy stocking rates on the land during years of lower-than-average rainfall, which is the key window when range vegetation can be degraded. The "boom and bust" in the cattle cycle would also be dampened as a result. The build up in non-livestock capital and investment would then permit societies to diversify their economies. This diversification could spur growth of urban job opportunities and mitigate the incidence of poverty among pastoral and agro-pastoral households. Mitigating poverty would then reduce the specter of poor people being engaged in destructive activities such as charcoal making, harvesting of green fuel wood, and opportunistic cultivation.

Agricultural sustainability. A sustainable agriculture is one where interventions are: (1) beneficial—or at least neutral—for the environment; (2) socially acceptable; and (3) economically profitable. The premise behind our project is that, left to their own devices, traditional pastoral or agro-pastoral production systems in our study region are unsustainable. For example, there is a loss of land to population growth and environmental degradation. There is an unraveling of the traditional social order in some cases, which can often be traced to competition for limited resources. There is abundant evidence that whether due to poor demand, bad

infrastructure, and/or inadequate marketing strategies of producers, pastoralism in the region is typically unprofitable. Evidence of unsustainability includes things like the chronic need to feed tens of thousands of people in the region each year, the re-location of poor households nearer to towns and settlements where they engage themselves in petty trade to stay alive, and the increasing poverty and declining living standards of pastoralists in general. By coming up with risk management tools, which in part should allow pastoralists and agro-pastoralists to save and invest outside of their traditional sphere, the resulting investment surge for education and entrepreneurial activity in towns and settlements should primary lead to growth of local economies with benefits for the environment, social order, and pastoral economy. As outlined immediately above, our risk management inter-ventions range from neutral to positive for the environment, which conforms to the first criterion of sustainable agriculture. Accumulation of wealth and efforts to mitigate social conflicts should allow the social fabric to heal—poverty is bad for the maintenance of traditional cultures. This fits the second criterion. The third criterion is dealt with by several economic outcomes that vary in terms of the relevant time scale. Short-term benefits would include an expansion of local markets for pastoral products. Longer-term benefits would include allowing more pastoralists to emigrate out of the traditional sector due economic diversification and increased employment opportunities in towns and settlements. Facilitation of emigration is the ultimate humanitarian solution to the risk-management dilemma for pastoralists. This is because population growth reduces resources per capita and therefore increases vulnerability of populations to endogenous and exogenous shocks.

Contributions to United States agriculture. The main contribution of this project to United States agriculture is primarily in terms of providing a "wake-up call" for research and extension professionals to the importance of risk management for the small to average-sized livestock producer. As will be noted below, the need for risk management by American producers may be increasing as profit margins get slimmer and the social and economic complexity of agriculture increases. It is fair to say that a commodity perspective has been pre-eminent in agricultural research and outreach in the United States. This has contributed to a lack of a relevant systems approach that could better integrate academic disciplines and deal more-effectively with real-world problems. Risk management can be an important contribution in this regard. Risk management is simultaneously economic, social, and ecological. The ability to better manage risks is an important attribute of successful farmers and ranchers. While livestock producers in the United States are under no imminent threat of starvation or extreme destitution comparable to pastoralists in northern Kenya or southern Ethiopia, there are commonalities in terms of how risks are conceptualized and interact to cause problems. For example, it has been forwarded by Holechek et al. that beef producers in New Mexico should diversify their assets and investments to mitigate economic downturns that repeatedly result from cyclic fluctuations in beef prices. This is exactly the same concept that we have for east African pastoralists. Education and access to investments are the main constraints for New Mexico ranchers—similar to prominent implementation constraints for east African pastoralists. Whether drought cycles are predictable or not, and the possible influence of phenomena like El Niño on precipitation regimes, is a core issue of debate for agriculture in the United States as well as east Africa. Global trade affects the United States beef producer and the East African pastoralist. The advent of the North American Free Trade Agreement (NAFTA) could serve to dampen peak prices received US cow-calf operators because of increased importation of cheaper Mexican beef. Research remains to be done that could confirm this widely held suspicion. The specter of NAFTA, however, probably influences behavior of US producers by increasing their perceived risk on prices and possibly discouraging production investment. Currently, the cross-border flow of live cattle is officially restricted between Ethiopia and Kenya. We do not know the rationale for this restriction, nor its effects on household economics on either side of the border. Answers to this will be provided by applied research on the GL-CRSP, which may shed new light on the costs and benefits of free trade in general—even as applicable to agriculture

in the United States. Our project will communicate such findings and influence the American research community, and hence the United States agricultural community, through a variety of research and outreach publications.

Contributions to host countries. Contributions to our host countries will mostly be felt through our outreach activities (described above) and training of host-country nationals. Outreach will primarily have impact on project beneficiaries—pastoralists and agro-pastoralists—but it will also have impact on development professionals and their organizations that link to us directly. In the training sphere our past contributions have also included computers, books, sponsorship for people to attend international conferences and other technical support for our main academic partner in Kenya, Egerton University. A broadening of our collaborative research role will benefit KARI-Marsabit (Kenya) and OARI-Yabelo (Ethiopia).

Linkages and networking. This has been previously covered in our section on Outreach.

Collaboration with IARCs and other CRSPs. We collaborate with the International Livestock Research Institute (ILRI) in both Ethiopia and Kenya. We typically hold our workshops at ILRI conference facilities. Some administrative and logistical support is provided to us by ILRI. We have had a link to Dr. Mohammed Jabbar under the marketing theme at ILRI-Ethiopia. We have strengthened ties to ILRI theme 2 (Enabling Innovations) under the auspices of the Crisis Mitigation Office (CMO) headed by Dr. Jean Ndikumana of ILRI-Kenya. We have also more recently linked to Dr. Patti Kristjanson also of ILRI-Kenya. The other CRSP we have connected to in the past is the BASIS CRSP. Drs. Peter Little and Christopher Barrett, US PIs on the GL-CRSP, and Prof. Abdillahi Aboud, regional PI on the GL-CRSP, used to be participants on the BASIS CRSP. The GL-CRSP and BASIS CRSP shared an interest in policy and economic issues that deal with cross-border relations.

Other Contributions

Support for free markets and broad-based economic growth. Interventions that will be advocated by our project will be in direct support of free markets and economic growth. Some of this has been previously described. This prominently involves linkages between markets and formation of benefits-oriented cooperatives to empower pastoralists at the local level. At our biennial workshop in Njoro (2001), some presentations dealt with outreach ideas to assist pastoralists to form their own cooperative associations to spur development processes—the idea being that a local association could form and pool capital resources to first organize a community savings and credit association. This would be an impetus for the group to procure production inputs and invest to improve their marketing capability to make themselves less vulnerable to trading bottlenecks. A group, for example, could purchase a large truck and independently handle livestock shipping. The outreach entity would only provide the initial training and a few select inputs to get it rolling. The success of such an endeavor would rely heavily on the availability of livestock and grain markets and their efficiency of operation. Our initiatives in livestock marketing research, and attempting to forge a partnership with private sector livestock exporters also are key elements indicating our awareness of the importance of commerce and the private sector. Taken together, these areas of emphasis reflect the functioning of free markets, a role for agribusiness, and developing a capability for pastoralists to empower themselves.

Contributions to, and compliance with, USAID Mission objectives. Our project contributes to and complies with Mission objectives in each country by dealing with food security, economic growth, the environment, and privatization issues. We have solid contacts with prominent people in USAID Missions in both Kenya and Ethiopia.

Concern for individuals. Our project incorporates a concern for individuals in several ways. One is through technical and advanced training opportunities, with a focus on host-country nationals at the master's and doctoral levels. Other evidence is provided by how we have organized

our applied research and outreach. For research, we realize that improved risk management will ultimately occur at the level of the individual. For outreach, priorities like public education, conflict mitigation, and formation of benefits-oriented cooperatives are a testimony to the value we place on helping individuals improve their lives by being able to deal with risk by making more informed choices.

Support for democracy. Voluntary, benefits-oriented producer cooperatives are one form of grass-roots democracy in action. We have also been asked by our partners in our outreach activities to help pastoral people involved in our pilot projects to better communicate their needs and desires to local politicians.

Humanitarian assistance. Our program of applied research and outreach is the embodiment of humanitarian assistance. Outreach will, in large measure, help set an agenda to guide more research as well as outreach. Research will therefore will very relevant to solving problems related to the "human condition" in the study region.

Leveraged Funds and Linked Projects

The total estimated value for leveraged funds for the PARIMA project during 2005 is $451,758. This was distributed among 12 linked projects or fund sources. The largest linked project was the Ethiopian Outreach component funded by the USAID Mission to Ethiopia ($163,500), followed closely by contributions to degree training through Cornell University ($125,469). The remaining amounts varied from $38,672 (obtained from both World-Bank Japan and the Portuguese Foundation) for graduate student support at Cornell University, to $31,000 (degree training support from the University of Kentucky), $1,155 in-kind support from the Kenya Agricultural Research Institute (Marsabit) and a $150 in-kind contribution from Action for Development (AFD), a local NGO in southern Ethiopia.

Training

Degree - In progress

Marc Bellamare. PhD. 2006. Agricultural Economics. Cornell University, Ithaca, New York.

Karen Greenhough. PhD. 2007. Anthropology. University of Kentucky, Lexington, Kentucky.

Getachew Haile. MS. 2007. Range Science. Alemaya University, Harar, Ethiopia.

Vivian Hoffmann. PhD. 2006. Agricultural Economics. Cornell University, New York.

Abdulahi Dima Jillo. PhD. 2006. Human Ecology. Egerton University, Njoro, Kenya.

Andrew Mude. PhD. 2006. Agricultural Economics. Cornell University, New York.

Dejene Debsu Negassa. PhD. 2007. Anthropology. University of Kentucky, Lexington, Kentucky.

Sintayehu Mesele. MS. 2007. Range Science. Alemaya University, Harar, Ethiopia.

Daniel Murphy. PhD. 2008. Anthropology. University of Kentucky, Lexington, Kentucky

Mark Mutinda. PhD. 2006. Human Ecology. Egerton University, Njoro, Kenya.

Nicholas OleKaikai. MS. 2006. Human Ecology. Egerton University, Njoro, Kenya.

Paulo Santos. PhD. 2006. Agricultural Economics. Cornell University, Ithaca, New York.

Amare Teklu Yirbecho. PhD. 2006. Natural Resources. Cornell University, Ithaca, New York, USA.

Degree - Completed

Hogset, Heidi. 2005. Doctoral degree in Applied Economics & Management. Cornell University, Ithaca.

Lentz, Erin. 2005. Masters degree in Applied Economics & Management. Cornell University, Ithaca.

Munyao, Kioko. 2005. Master's of Professional Studies (MPS) degree in International Agriculture & Rural Development. Cornell University. Ithaca.

Seifu, Mahelt. Senior research project: "Goat Restocking for Vulnerable Pastoral Elders in Yabelo Woreda." B.Sc. awarded July 2005.

Debub University, Dept. Range & Animal Sciences.

Worku, Debebe. Senior research project: "Bush Management Practices in Borana: A Case Study in the Dida Hara Community." B.Sc. awarded July 2005. Debub University, Dept. Range & Animal Sciences.

Tsegaye, Dereje. Senior research project: "Prevalence of Major Animal Diseases in and around Yabello." B.Sc. awarded July 2005. Debub University, Dept. Range & Animal Sciences.

Asmare, Andualem. Senior research project: "Milk Supply and Marketing by Pastoralists Living around Yabelo Town, Southern Ethiopia." B.Sc. awarded July 2005. Mekele University, Dept. Animal, Rangeland & Wildlife Sciences.

Non-Degree Training (Post-Doctoral Associates, in progress)

Solomon Desta, Post-doctoral associate. 1999-present. Pastoral Development. Utah State University.

Getachew Gebru, Post-doctoral associate. 2000-present. Pastoral Development. Utah State University.

Non-Degree Training (Workshops, Short Courses, Field Tours)

Outreach (funded by the USAID Mission to Ethiopia)

Participatory Extension to Enhance Development. Venue: Yabelo, Ethiopia. Trainer: Mr. Seyoum Tezera. Dates: October 25-26, 2004. Number of participants: 19.

Participatory Extension to Enhance Development. Venue: Negele, Ethiopia. Trainer: Mr. Seyoum Tezera. Dates: November 4-5, 2004. Number of participants: 18.

Rural Savings & Credit Training for Illiterates (Members and Leaders). Venue: Negele, Ethiopia. Trainers: Mr. Seyoum Tezera and staff from the Oromia Agricultural Development Office and Oromia Cooperative Promotion Bureau. Dates: January 25 to February 05, 2005. Number of participants: 586.

Fifth Cross-Border Collaboration, Activity Harmonization, and Information-Sharing Workshop for Kenya and Ethiopia—General Meeting. Venue: Moyale, Ethiopia. Convenors: Dr. Solomon Desta, Mr. Chachu Tadecha, Dr. Getachew Gebru, and Mr. Seyoum Tezera. Dates: February 16-17, 2005. Number of participants: 54.

Fifth Cross-Border Collaboration, Activity Harmonization, and Information-Sharing Workshop for Kenya and Ethiopia—Steering Committee Meeting. Venue: Moyale, Kenya. Convenors: Mr. Seyoum Tezera, and Chachu Tadecha. Date: August 8, 2005. Number of participants: 40.

Training in Cross-Border Conflict Management. Venue: Moyale, Ethiopia. Trainers: M. Kiragu, C. Tadecha, Dr. S. Desta, S. Tezera, and A. Wako. Dates: February 16-17, 2005. Number of participants: 54.

Rural Savings & Credit Training for Illiterates (Members and Leaders). Venue: Moyale, Ethiopia. Trainers: S. Tezera and staff from the Oromia Agricultural Development Office and Oromia Cooperative Promotion Bureau. Dates: March 5-10, 2005. Number of participants: 240.

Rural Savings & Credit Training for Illiterates (Members and Leaders). Venue: Dubluk, Ethiopia. Trainers: S. Tezera and staff from the Oromia Agricultural Development Office and Oromia Cooperative Promotion Bureau. Dates: March 12-17, 2005. Number of participants: 240.

Training for Leaders of Cooperative Groups. Venue: Yabelo, Ethiopia. Trainers: S. Tezera and staff from Action for Development (AFD) and the Oromia Cooperative Promotion Bureau. Dates: March 25-April 5, 2005. Number of participants: 24.

Training for Leaders of Cooperative Groups. Venue: Negelle, Ethiopia. Trainers: S. Tezera and staff from Action for Development (AFD) and the Oromia Cooperative Promotion Bureau. Dates: May 5-10, 2005. Number of participants: 24.

Training for Members of Cooperative Groups. Venue: Finchewa, Ethiopia. Trainers: S. Tezera and staff from Action for Development (AFD) and the Oromia Cooperative Promotion Bureau. Dates: May 15-25, 2005. Number of participants: 150.

Small-Scale Business Development Training

for Illiterates. Venue: Negelle, Ethiopia. Trainers: S. Tezera, D. Amosha, and staff of the Oromia Agricultural Development Bureau and Oromia Cooperative Promotion Bureau. Dates: June 20-24, 2005. Number of participants: 48.

Training in Peace Building and Conflict Management—Focus on Somali/Boran Issues. Venue: Negelle, Ethiopia. Trainers: S. Tezera and Guji Zone Administrators. Dates: June 21-23, 2005. Number of participants: 51.

Sixth Cross-Border Collaboration, Activity Harmonization, and Information-Sharing Workshop for Kenya and Ethiopia—Special General Meeting Concerning Cross-Border Conflict. Venue: Moyale, Kenya. Convenors: Mr. Seyoum Tezera and Mr. Chachu Tadecha. Dates: August 6-7, 2005. Number of participants: 150.

Second Field Tour of the Rangelands for Policy Makers. Venue: Central Borana Plateau. Convenors: Mr. Dadhi Amosha and Dr. Getachew Gebru. Dates: August 10-17, 2005. Number of participants: 5.

Fourth Cross-Border Women's Tour: Self-Organization for Development. Venue: Central Borana Plateau. Trainers: S. Tezera and Kenyan women mentors. Dates: August 8-17, 2005. Number of participants: 832.

Second Pastoral Producers Tour to Livestock Export Facilities and Dairy Cooperatives in the Ethiopian Highlands. Venue: Addis Ababa and vicinity. Trainers: Mr. S. Tezera and D. Amosha. Dates: September 12-24, 2005. Number of participants: 19.

Research

Participatory Research Approaches. Venue: OARI, Yabelo. Trainers: Drs. Solomon Desta and Getachew Gebru. Dates: October 4-11, 2004. Number of participants: 8.

Use of Prescribed Fire for Rangeland Management. Venue: OARI, Yabelo. Trainers: Mr. Eric LaMalfa, Dr. Getachew Gebru, and Mr. Dadhi Amosha. Dates: February 20-26, 2005. Number of participants: 28. .

Participatory Research Approaches. Venue: KARI/NALRC, Marsabit. Trainers: Drs. George Keya and Solomon Desta, and Mr. D. Mbuvi. Dates: April 12-16, 2005. Number of participants: 16.

Digitizing for Geographical Information Systems (GIS). Venue: KARI/NALRC, Marsabit. Trainers: P. Maingi and M. Nyamai (from KARI HQ, Nairobi). Dates: May 7-13, 2005. Number of participants: 11.

Primary Collaborating Personnel

United States

Dr. Christopher Barrett. Principal Investigator, Professor. Department of Applied Economics & Management. Cornell University, Ithaca, New York.

Dr. Layne Coppock. Lead Principal Investigator, Associate Professor. Department of Environment & Society. Utah State University, Logan, Utah.

Dr. Cheryl Doss, Director of Graduate Studies, International Relations Program. Yale University, New Haven, Connecticut.

Dr. Peter Little. Principal Investigator, Professor. Department of Anthropology. University of Kentucky, Lexington, Kentucky.

Dr. John McPeak. Principal Investigator, Assistant Professor. Department of Public Administration, Maxwell School. Syracuse University, Syracuse, New York.

Ethiopia

Dr. Mohammed Jabbar. Research Economist. International Research Institute (ILRI).

Dr. Pedro Carrillo. Coordinator, Southern Tier Initiative. USAID Mission to Ethiopia.

Dr. Fisseha Meketa. Senior Expert, Save the Children (SCF/USA).

Mr. Sora Adi. Senior Expert, Borana Lowlands Pastoral Development Project (BLPDP/GTZ).

Mr. Aliye Hussen. Director General, Oromia Agricultural Research Institute (OARI)

Dr. Lemma Gizachew. Head of Livestock Research, Oromia Agricultural Research Institute (OARI)

Ms. Feleketch Lemecha. Senior Staff Member, Oromia Agricultural Research Institute (OARI).

Kenya

Prof. Abdillahi Aboud. Regional Principal Investigator, Professor, Department of Natural Resources and Faculty of Environmental Resource Development (FERD) at Egerton University.
Dr. Hussein Mahmoud, Lecturer, Department of Geography and Faculty of Environmental Resource Development (FERD) at Egerton University.
Dr. George Keya, Director, National Arid Lands Research Center (NALRC), Kenya Agricultural Research Institute (KARI).
Dr. Jean Ndikumana, Team Leader, Crisis Mitigation Office (CMO), International Livestock Research Institute (ILRI).
Dr. Patti Kristjanson, Research Scientist, International Livestock Research Institute (ILRI).
Mr. Michael Ochieng Odhiambo, Executive Director, RECONCILE, Nakuru.
Mr. Chachu Tadecha, Director, Community Initiatives Facilitation and Assistance (CIFA).
Ms. Miriam Cherogony, Staff Member, K-REP Development Agency.
Ms. Allyce Kureiya, Staff Member, SNV-Isiolo.
Mr. Godana Doyo, Staff Member, Arid Lands Resource Management Project (ALRMP).

Primary Collaborating Institutions

United States

Department of Environment & Society
Utah State University
Logan, UT 84322-5215
Telephone: 435-797-1790
Fax: 435-797-4048

Department of Anthropology
University of Kentucky
Lexington, KY 40506-0024
Telephone: 859-257-6923
Fax: 859-323-1959.

Department of Applied Economics & Management
Cornell University
Ithaca, N.Y. 14853-7801
Telephone: 607-255-4489
Fax: 607-255-9984.

Department of Public Administration
Maxwell School, Syracuse University
Syracuse, N.Y. 13244
Telephone 315-443-4000
Fax 315-443-9721

Ethiopia

International Livestock Research Institute (ILRI)
P.O. Box 5689
Addis Ababa, Ethiopia
Telephone: 251-1-463-215
Fax: 251-1-461-252.

United States Agency for International Development (USAID) Mission to Ethiopia
P.O. Box 1014
Addis Ababa
Telephone: 251-1-510-088
Fax: 251-1-510-043

Oromia Agricultural Development Bureau (OADB)
P.O. Box 8770
Addis Ababa
Telephone: 251-1-155-303
Fax: 251-1-515-905.

Oromia Cooperative Promotion Bureau (OCPB)
P.O. Box 8648
Addis Ababa
Telephone: 251-1-158-737
Fax: 251-1-515-905

Oromia Pastoral Development Commission (OPDC)
P.O. Box 1192
Adama
Telephone: 251-2-123-900/123-700
Fax: 251-1-123-735

Oromia Agricultural Research Institute (OARI)
P.O. Box 1195
Adama
Telephone 251-2-115-381/82/83
Fax 251-2-128-419

Ethiopian Agricultural Research Organization (EARO)
P.O. Box 2003
Addis Ababa
Telephone 251-1-612-633
Fax: 251-1-611-222

Save the Children USA
P.O. Box 387
Addis Ababa
Telephone: 251-1-223476
Fax: 251-1-728045

Volunteers in Overseas Cooperative Action (VOCA)
P.O. Box 548, Code 1110
Addis Ababa
Telephone: 251-1-510-508
Fax: 251-1-531-530

Kenya

Faculty of Environmental Sciences
And Resource Development (FERD)
Egerton University
P.O. Box 536
Njoro
Telephone; 254-37-62038
Fax: 254-37-61213

International Livestock Research Institute (ILRI)
P.O. Box 30709
Nairobi
Telephone: 254-20-422-3000
Fax: 254-20-422-3001

Community Initiatives Facilitation and Assistance (CIFA)
P.O. Box 147
Marsabit, Kenya

Arid Lands Resource Management Project (ALRMP)
P.O. Box 53547
Nairobi
Telephone: 254-2-227-496
Fax: 254-2-227-982

Kenya Agricultural Research Institute (KARI)
P.O. Box 57811
Nairobi
Telephone: 254-2-583-301
Fax: 254-2-583-344.

Ministry of Livestock Development & Fisheries
P.O. Box 30028
Nairobi
Telephone: 254-2-721-005
Fax: 254-2-721-983.

Resource Conflict Institute (RECONCILE)
P.O. Box 7150
Nakuru
Telephone: 254-37-44940
Fax: 254-37-212865

PUBLICATIONS

Aboud, A.A., P.K. Kisoyan, and D.L. Coppock. (in press). Agropastoralists' wrath for the *Prosopis* tree: The case of the Il Chamus of Baringo District, Kenya. Research Brief 05-02-PARIMA. Global Livestock Collaborative Research Support Program. University of California, Davis.

Barrett, C.B., and W. Luseno. (2004). Decomposing producer price risk: A policy analysis tool with an application to northern Kenyan livestock markets. Food Policy 29:393-405.

Barrett, C.B., D. Lee, and J. McPeak. (2005). Institutional arrangements for rural poverty reduction and resource conservation. World Development 33(2): 193-197.

Desta, S., Gebru, G., Tezera, S., and D.L. Coppock. (in press). Linking pastoralists and exporters in a livestock marketing chain: Recent experiences from Ethiopia. Research Brief 05-06-PARIMA. Global Livestock Collaborative Research Support Program. University of California, Davis.

Haro, G., G. Doyo, and J. McPeak. (in press). Linkages among community, environmental, and conflict management: Experiences from northern Kenya. Research Brief 05-01-PARIMA. Global Livestock Collaborative Research Support Program. University of California, Davis.

Hogset, H. (2005). Social Networks and Rural Development: Theory and Applications in Kenya. Doctoral Dissertation. Dept. of Applied Economics and Management, Cornell University, Ithaca.

Jillo, A.D., M. Mutinda, A.A. Aboud, and D.L. Coppock. (in press). Degree of sedentarization affects risks and conflicts for the Waso Boran in northern Kenya. Research Brief 05-08-PARIMA. Global Livestock Collaborative Research Support Program. University of California, Davis.

Keya, G.A., M. Ngutu, A. Adongo, and I. Tura. (in press). Bridging the gap between agricultural technology development and adoption in northern Kenya. Research Brief 05-05-PARIMA. Global Livestock Collaborative Research Support Program. University of California, Davis.

LaMalfa, E., and D.L. Coppock (eds. and compilers). (2005a). Use of Prescribed Fire in Rangeland Management. Training manual for a short-course held 20-26 February at the Southern Rangelands Development Unit (SORDU). Yabelo, Ethiopia. 241 pp.

LaMalfa, E., and D.L. Coppock. (2005b). Rebuilding the capacity to burn: Community development and rangeland productivity. Pages 8-11 in Ruminations - Newsletter of the Global Livestock Collaborative Research Support Program. University of California at Davis. Spring Issue.

Lentz, E. (2005). Targeting Food Aid to Improve Food Security. Master's thesis. Dept. of Applied Economics and Management, Cornell University, Ithaca.

Little, P. (2005). Unofficial trade when states are weak: The Case of cross-border commerce in the Horn of Africa. Research Paper no. 2005/13. World Institute for Development Economics Research, United Nations University. Helsinki, Finland.

Little, P., and H. Mahmoud (in press). Cross-border cattle trade in the Ethiopia/Kenya and Somalia/Kenya borderlands. Research Brief 05-03-PARIMA. Global Livestock Collaborative Research Support Program. University of California, Davis.

Lybbert, T., C. Barrett, S. Desta, and D.L. Coppock. (2004). Stochastic wealth dynamics and risk management among a poor population. The Economic Journal 114: 750-777.

McPeak, J. (2005a) Individual and collective rationality in pastoral production: Evidence from northern Kenya. Human Ecology 33(2): 171-197.

McPeak, J. (2005b). Simulation noise and the estimation of land-use decisions in Kenya. In A. Alberini and R. Scarpa (eds) Applications of Simulation Methods in Environment and Resource Economics Kluwer Academic Publishers. Pp 355-371.

McPeak, J. (in press). Do livestock transfers among Gabra herders insure against herd loss? Research Brief 05-09-PARIMA. Global Livestock Collaborative Research Support Program. University of California, Davis.

McPeak, J., G. Haro, and G. Doyo. (2005). Linkages between community, environmental, and conflict management: Experiences from northern Kenya. World Development 33(2): 285-299.

Munyao, S. (2005). Land Use Change in the Hurri Hills and the Implications for Pastoralism and Biodiversity Conservation in Marsabit District, Kenya. Masters of Professional Studies (MPS) Project Paper in International Agriculture and Rural Development. Cornell University, Ithaca.

Munyao, K., and C.B. Barrett. (in press). Decentralization and it's effect on pastoral resource management in northern Kenya. Research Brief 05-04-PARIMA. Global Livestock Collaborative Research Support Program. University of California, Davis.

Santos, P., and C.B. Barrett. (in press). Herd dynamics, social networks, and informal transfers among southern Ethiopian pastoralists. Research Brief 05-07-PARIMA. Global Livestock Collaborative Research Support Program. University of California, Davis.

Abstracts and Presentations

Aboud, A.A. (2005). PARIMA's role in capacity building at Egerton University, Kenya. Presentation given at the GL-CRSP Program Conference, held

23-26 June at the University College of Dublin, Ireland.

Barrett, C.B. (2004). Mixing qualitative and quantitative methods of analyzing poverty dynamics. Presentation given during March at the Kenya Institute for Public Policy Research and Analysis, Nairobi, Kenya.

Coppock, D.L. (2005a). Mitigating recurrent drought crises in the southern Ethiopian rangelands. Invited paper presented at a symposium entitled, "The Science of Agriculture and Food in Times of Crisis." 71st Annual Meeting of the American Association for the Advancement of Science (AAAS), held 17-21 February, Washington, DC.

Coppock, D.L. (2005b). The PARIMA Project: Overview. Presentation given at the GL-CRSP Program Conference, held 22-25 June, University College, Dublin, Ireland.

Desta, S., and G. Gebru. (2005). PARIMA and participatory research. Presentation given at the GL-CRSP Program Conference, held 23-26 June at the University College of Dublin, Ireland.

Desta, S., D.L. Coppock, S. Tezera, and G. Gebru. (2005). Avenues for enhancing traditional livelihoods from grasslands: Income diversification among pastoral women's groups in southern Ethiopia. Volunteer Poster presented at the XX International Grasslands Congress, held 26 June-1 July, University College, Dublin, Ireland.

Gebru, G. (2005). Recent experiences of PARIMA in the Guji and Borana zones: Supply of sheep and goats to exporters by pastoral livestock marketing groups. Invited presentation given at a Sensitization Workshop on Development of Livestock Market Information Systems in Ethiopia, held 22 August, Adama, Ethiopia.

Gebru, G., S. Desta, S. Tezera, and D.L. Coppock. (2005a). Goats—a pathway to food security: The case of pastoral women's groups from southern Ethiopia. Invited paper given at an occasional conference of the Veterinarie sans Frontier (VSF), held April 15 at the Belgian Parliament, Brussels, Belgium.

Gebru, G., S. Desta, and D.L. Coppock (2005b). Institutional innovations to market linkages: the case of pastoral marketing groups in southern Ethiopia. Invited paper given in the plenary session of the Annual Meeting of the Ethiopian Veterinary Association (EVA), held June 19 at Africa Hall, Economic Commission for Africa, Addis Ababa, Ethiopia.

Hussen Asoba, A., (2005). PARIMA's role in regional capacity building at OARI, Yabelo, Ethiopia. Presentation (given by G. Gebru) at the GL-CRSP Program Conference, held 23-26 June at the University College of Dublin, Ireland.

Jillo, A.D., A.A. Aboud, and D.L. Coppock. 2005. Of grasslands and guns: natural-resource based conflict among the Waso Borana pastoralists of northern Kenya. Volunteer Poster presented at the XX International Grasslands Congress, held 26 June-1 July, University College, Dublin, Ireland.

Keya, G. (2005). PARIMA's role in regional capacity building at KARI/NALRC, Marsabit, Kenya. Presentation given at the GL-CRSP Program Conference, held 23-26 June at the University College of Dublin, Ireland.

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Lead Principal Investigator

D. Layne Coppock, Department of Environment and Society, Utah State University, Logan, UT 84322-5215. Telephone (435) 797-1262, Fax (435) 797-4048, Email: LCoppock@cc.usu.edu.

ENAM in Africa: Enhancing child Nutrition through Animal source food Management

Narrative Summary

Poverty was one of the primary constraints that stakeholders identified to the inclusion of animal source foods (ASF) in children's diets in Ghana. During the first year, the ENAM project began activities to support the development of income generation activities (IGA) that would be feasible to carry out and sustainable by the intervention communities. We documented successful IGA strategies that were used by non-governmental organizations working in the study sites to learn from their experiences. The IGA documentation exercise demonstrated an emphasis of current strategies on increasing incomes with little or no emphasis on household food security and child nutrition. The results of this review were systematized in a manual of "best practices" and shared during a 2-d workshop with participating stakeholders from the local, district, and national levels. A baseline survey was completed in the six (3 rural and 3 semi-urban) intervention and six (3 rural and 3 semi-urban) matching control communities to document household food security, expenditure patterns, nutrition knowledge and attitudes, dietary intakes, and nutritional status of children. The initial analysis of the baseline data demonstrated a more acute problem in children's nutritional status among the semi-urban communities than the rural communities in the coastal region. There were some differences between intervention and control sites in all of the regions in baseline diet diversity that will have to be accounted for in the final analyses. The research will provide the information needed to determine if the intervention goals are met and the mechanisms (i.e., which of the interventions [e.g., nutrition education, IGA, technical assistance] or combination of interventions affected change?) by which the community-based activities improve the dietary intake of ASF and nutritional status of young children. In addition to the research activities, ENAM has initiated support of graduate training through support of short courses as well as the master's program from one Ugandan student and support of research for four Ghanaian graduate students. Finally, ENAM has begun work on developing a nutrition extension curriculum that will bridge the areas of nutrition and agriculture.

Research

There were five activities proposed for the first year of the ENAM grant. The problem statement, approach (including what was planned, why it was important, and how it was to be accomplished), and progress for each activity are described below. As this was the first year of the project, the problem model has not been modified based on last year's results, and is not addressed here.

Activity One: Administrative Set-up of GL-CRSP Project in Ghana

Problem Statement and Approach. This was the first year of the ENAM project; therefore, the first step was to address the administrative needs of the project. Formal administrative collaborations between Iowa State University and the University of Ghana needed to be established, project offices and project personnel were needed.

Planned activities. The administrative activities included establishing a subcontract and the financial reporting and communications between ISU and University of Ghana, setting up the project infrastructure at University of Ghana and at study sites, hiring and training project staff, and establishing liaisons between the project and governmental and non-governmental organizations.

Importance. The establishment of close liaisons with governmental agencies and non-governmental organizations was important for advancing the development process. The selected sites are dynamic communities that interact, as a whole or as independent households, with different governmental and non-governmental organizations working in health, education, agriculture, and other areas. Thus, it was important for the ENAM project to have a thorough understanding of the resources to which households have access to leverage the project funds so that their impact is greatest, and to build on these community resources and help them become sustainable.

Plans to accomplish activity. A project manager (Dr. Esi Colecraft) was hired at ISU and moved to Ghana to oversee all activities of the ENAM project which facilitated this administrative relationship between universities. The agency liaisons were nurtured by including managerial and field staff from governmental and non-governmental organizations in the data collection and analysis process. Frequent personal communication with the staff of these agencies were planned to help build a sense of ownership with the project.

Progress.

Planned outputs and completion of tasks:

1. Set up subcontract between ISU and University of Ghana: The subcontract was signed and has been revised to reflect the second year of the project.

2. Set up financial reporting and regular communications plan: Invoices have been regularly sent to ISU. Dr. Colecraft developed a system of logging communications and activities which is distributed to the ENAM team for review and modifications are added as appropriate. This log serves as a permanent record of project activities.

3. Establish necessary infrastructure at University of Ghana and at study sites: The Department of Animal Science provided office space for the project at U of Ghana. Field offices have been established in two of the three regions through rentals and an office was provided for the project by the Ministry of Food and Agriculture in Navrongo. Computer and communications equipment, office furniture, and motorized vehicles have been purchased.

4. Hire and train staff: All permanent staff have been hired (project field supervisor, 3 regional field assistants, an administrative assistant, and a driver). Training for the field assistants was carried out during June-July. A separate training for the field staff on use of the data collection tools was carried out by Colecraft and the Ghanaian collaborating researchers; Frederick Grant (a University of Ghana nutrition graduate student) assisted with the anthropometry training.

5. Establish liaisons with governmental and non-governmental organizations: The staff of different governmental and non-governmental organizations has been active with the project since the planning grant activities in 2003-04. The same agencies continued to work with us in 2005 and participated in in-depth interviews during the data collection period (February – May 2005) and assisted with the analysis of the IGA best practices data as well as the discussions about appropriate interventions for year 2 at the June 2005 workshop.

Activity Two: Documentation of Existing Activities and Local Support Capabilities

Problem Statement and Approach. The first planned research activity of ENAM was the documentation of income generation activities (IGA) that have been carried out with success by organizations working in the study sites to learn about successes in the area of activities of interest to this project.

Planned activities. Success of IGA projects was measured by their ability to improve household food security, family access to health and education services, improved health outcomes of household members, or sustainability of activities, as reported by the organizations. Specific questions of interest in the evaluation of these IGA were: a) the characteristics of existing successful ASF-related IGA and market linkage strategies in the communities, and the identification of potential activities to promote in study sites and the identification of local mentors to assist the project in the intervention stage with knowledge of the local conditions and expertise. The

analysis of the results was planned to be published in a manual of "best practices" that would be distributed to policy makers.

Importance. The IGA activity permitted the ENAM team and stakeholders involved in developing the interventions to learn from the experiences of projects that worked in the same region under similar conditions. Most of these experiences are not available in the research literature and only by conducting in-depth interviews with the staff, reviewing their project documents, visiting projects and interviewing participants, and engaging project staff in discussion in a 2-day workshop with other stakeholders was the information of their experiences available. The activity also permitted the examination of possible collaborations between the ENAM project and agencies for future collaborations.

Plans to accomplish activity. The activities were planned to be carried out by the newly hired Project Field Supervisor and the Program Manager, Dr. Colecraft. Data collection was planned for February – May, 2005. A 2-day workshop was planned for June when ISU faculty could attend. The outcome of the workshop was to be the consensus on interventions to suggest for the intervention communities. A manual was planned to be printed and widely distributed sharing the results of the "best practices" workshop.

Progress. We had no changes in our work plan.

Planned outputs and completion of tasks:

1. Data collection on on-going IGA projects and evaluation of their success: This activity was completed through interviews with project administrators, staff, and participants as well as direct observation of 18 agencies that worked in the study regions. An initial analysis of the data was completed by the ENAM Ghana team.

2. Summary of discussions on identification of possible activities to initiate: A summary of the findings was presented to 37 stakeholders at a 2-day workshop in June 2005 who represented national and regional government agencies, NGO's, community development professionals (agriculture extension and community health and nutrition), and researchers. Three agencies (ADRA, Freedom from Hunger, and Christian Rural Action Network were invited to share their experiences and gave presentations specific to their activities at the workshop). The stakeholders participated in the final analysis of the results and the development of intervention possibilities.

3. List of mentors: some mentors were identified through the data collection project of "best practices". Additional people will be identified as the activities start.

4. Manual describing the successes of activities: The manual was completed and distributed to stakeholders and policy makers. A copy was sent to the GL-CRSP office with the year 2 work plan.

5. Development of newsletters with update of project: The outline of the newsletter was developed and a list of targeted recipients and scheduled highlights was discussed. The first newsletter is planned for December 2005.

6. Workshop on best practices and launching project: This workshop is mentioned above under #2.

Activity Three: Development of Community-based Activities to Improve Interventions

Problem Statement and Approach. The outcome of the workshop was to be a consensus about the activities that should be initiated.

Planned activities. Prior to initiating any IGA in the communities, we planned to collect baseline data on variables of interest. This included the development and testing of data collection tools, the training of field assistants to use the tools, and the completion of the data collection. In addition, data entry programs with quality control were to be developed by an experienced university staff. The baseline values for food security, expenditure patterns, knowledge and attitudes, dietary intakes, and nutritional status were to be collected in the communities during this first year. Initiation of selected interventions at the community level were planned to start after the baseline collection. This would require the training of facilitators and the development of tools for periodic evaluations of the interventions.

Importance. The research component of this

project will provide the scientific evidence of the effectiveness of the different community-based interventions to increase access to ASF for young children and improve household food security and nutritional status of preschoolers. The control communities will serve as a means of comparing the progress related to the project to those changes that occur over time. The influence of other entities working in the community will be assessed on a periodic basis to determine their effect on development at the community- and household-level.

Plans to accomplish activity. The collection of baseline data was planned for July-September 2005. The project manager was responsible for overseeing the data collection; data was to be collected by the regional coordinators and project supervisor along with locally hired enumerators, sequentially in the three regions. The local enumerators were Ministry of Food and Agriculture staff who were given leave from their normal duties to assist us with the data collection and demonstrates the continued interest of MOFA in the ENAM project. In addition to the MOFA staff, we hired university students and members of a community-based organization (CBO) to assist.

Progress. The baseline data collection was completed by the end of the fiscal year, however; there was not time to initiate the training of the facilitators beyond the data collection tasks.

Planned outputs and completion of tasks:

1. Identification of specific activities to be initiated in the study sites: The workshop participants provided recommendations for specific activities for all three regions. These recommendations will be further examined by the communities and the community groups themselves to finalize the activity choices.

2. Data collection tools for the baseline data collection: These tools were completed in June while the ISU team met with the Ghana team. The tools were field tested in late June and finalized.

3. Trained staff for the baseline data collection: The regional coordinating staff were trained in community entrance and communication, use of the data collection tools, and collection of anthropometric measurements.

4. Completed baseline data collection: All baseline data were collected in the three regions and in the intervention and control sites between July – September 2005. A data entry system was designed and all data were entered and cleaned. A summary of the preliminary results are given in the next section. These results will be presented at the Experimental Biology meetings in San Francisco in 2006.

5. Trained facilitators for the intervention: Community facilitators have been identified in all of the communities. These individuals are the key contact to the communities and help to organize the invitations to participate in all activities that take place in their communities. They have participated in the training for the data collection so that they are well versed in the project and its activities.

Baseline data results. Two types of data were collected: (1) qualitative information on the community itself through interviews with local key informants and (2) quantitative information via questionnaires with all households with children 2-5 y of age. The communities that participated in the original planning grant in 2003-04 were selected to be the six intervention communities. Through community visits and discussions with community residents, in each region control sites were selected based on similar livelihoods, infrastructure, size, and apparent wealth. Care was taken to assure that the distance between an intervention and control site was sufficient to assure that we would keep independent samples. A brief summary of the data are presented for each of the three regions. The population size and cost estimates that were provided by the key informants in the interviews will be verified by the ENAM staff. A preliminary quantitative analysis is provided for each region in the accompanying tables (Tables 1-11); this analysis is on-going. The qualitative description of each site is given below. Although the control sites were selected to match the intervention communities as best as possible based on observations and information from key informants, the baseline survey demonstrated some important differences in livelihoods, diet, and child nutritional status between intervention and control sites in each region. These will need to be considered in the final analysis.

Table 1. The baseline characteristics of intervention and control communities for the Central Region of Ghana (coastal)

Characteristic of household	Rural			Semi-urban[1]		
	Intervention N=37	Control N=27	P-value[2]	Intervention N=61	Control N=81	P-value
Type			0.2644			0.3289
Nuclear	37.8 (14)[3]	51.9 (14)		46.7 (28)	55.0 (44)	
Extended	62.2 (23)	48.2 (13)		53.3 (32)	45.0 (36)	
Composition						
Household size	7.1 ± 0.5[4]	5.8 ± 0.5	0.0700	5.8 ± 0.3	6.1 ± 0.3	0.4032
Male (mean %)	46.1 ± 2.9	41.9 ± 3.5	0.3588	41.5 ± 2.9	44.0 ± 2.3	0.4913
Female	53.9 ± 2.9	58.1 ± 3.5		58.5 ± 2.9	56.0 ± 2.3	
age ³ 18y	42.6 ± 2.0	47.8 ± 2.5	0.1149	43.8 ± 1.9	43.9 ± 1.8	0.9463
age < 18y	57.4 ± 2.0	52.2 ± 2.5		56.2 ± 1.9	56.1 ± 1.8	
Characteristics of head						
Gender distribution			0.5019			0.0864
Male	70.3 (26)	77.8 (21)		52.5 (32)	66.7 (54)	
Female	29.7 (11)	22.2 (6)		47.5 (29)	33.3 (27)	
Ethnicity			0.0001			0.0027
Akan	54.1 (20)	11.1 (3)		77.0 (47)	95.1 (77)	
Ewe	24.3 (9)	81.5 (22)		3.3 (2)	2.5 (2)	
Ga-Adangme	10.8 (4)	0.0 (0)				
Other	10.8 (4)	7.4 (2)		19.7 (12)	2.5 (2)	
Residential status			0.2954			0.6402
Indigene/native	10.8 (4)	3.7 (1)		83.6 (51)	86.4 (70)	
Migrant	89.2 (33)	96.3 (26)		16.4 (10)	13.6 (11)	
Educational level			0.3363			0.7954
None-less than primary	37.8 (14)	25.9 (7)		45.9 (28)	45.7 (37)	
Primary	24.3 (9)	29.6 (8)		16.4 (10)	12.4 (10)	
Secondary	29.7 (11)	22.2 (6)		29.5 (18)	35.8 (290	
Higher than secondary	8.1 (3)	22.2 (6)		8.2 (5)	6.2 (5)	
Primary occupation			0.6638			0.0885
Farming				42.3 (27)	66.7 (54)	
Fishing/fish monger	59.5 (22)	48.2 (13)		14.8 (9)	6.2 (5)	
Trading	10.8 (4)	10.8 (4)		23.0 (14)	17.3 (14)	
Skilled artisan				14.8 (9)	7.4 (6)	
Other	29.7 (11)	37.0 (10)		3.3 (2)	2.3 (2)	
Religion			0.4842			0.0062
Traditional	29.7 (11)	25.9 (7)		13.1 (8)	6.2 (5)	
Christian	70.3 (26)	70.4 (19)		72.1 (44)	91.4 (74)	
Muslim/Islamic						
Other	0.0 (0)	3.7 (1)		14.8 (9)	2.5(2)	

[1]Semi-urban sites were closer to major urban centers, had easier access to major roads, and had more community infrastructure.
[2]Analyses used Student's t-test for continuous variables and Chi-square or Fischer's exact test for categorical variables. [3]% (n) [4]Mean ± SEM

Table 2. Household income sources and assets of intervention and control communities for the Central Region of Ghana (coastal)

Income source	Rural			Semi-urban[1]		
	Intervention	Control	P-value[2]	Intervention	Control	P-value
Tree or crop farming	21.6 (7) [3]	0.0 (0)	0.0166	83.6 (51)	88.9 (72)	0.3601
Livestock/poultry farming	37.8 (14)	37.0 (10)	0.9479	39.4 (24)	25.9 (21)	0.0889
Fishing/fish mongering	83.8 (31)	77.8 (21)	0.5432	24.6 (15)	8.6 (7)	0.0093
Hunting/gathering	0.0 (0)	7.4 (2)	0.1741	14.8 (9)	25.9 (21)	0.1064
Processing (e.g., shea butter, charcoal, gari)	10.8 (4)	0.0 (0)	0.1316	36.1 (22)	2.5 (2)	<0.0001
Trading	51.4 (19)	33.3 (9)	0.1513	54.1 (33)	37.0 (30)	0.0428
Laborer	21.6 (8)	37.0 (10)	0.1755	8.2 (5)	19.8 (16)	0.0548
Salaried employee (including self-employment)	16.2 (6)	33.3 (9)	0.1100	36.1 (22)	19.8 (16)	0.0297
Other	14.8 (4)	21.6 (8)	0.4908	23.0 (14)	21.0 (17)	0.7792
Source of land for farming						
Purchased/Rented	12.5 (1)	0.0 (0)		12.0 (6)	1.4 (1)	0.0412
Family/communal land/gift	37.5 (3)	0.0 (0)		84.0 (42)	95.8 (69)	
Sharecropping	37.5 (3)	0.0 (0)		4.0 (2)	2.8 (2)	
Other						

[1]Semi-urban sites were closer to major urban centers, had easier access to major roads, and had more community infrastructure.
[2]Analyses used Student's t-test for continuous variables and Chi-square or Fischer's exact test for categorical variables. [3] % (n)

Table 3. Household food security in intervention and control communities for the Central Region of Ghana (coastal)

	Rural			Semi-urban[1]		
	Intervention	Control	P-value[2]	Intervention	Control	P-value
Number of months of severe food shortage	2.19 ± 0.16[3]	2.19 ± 0.20	0.9870	2.69 ± 0.17	2.63 ± 0.12	0.7717
0-2	62.2 (23)[4]	59.3 (16)	0.6434	59.0 (36)	44.4 (36)	0.0024
3-4	35.1 (13)	40.7 (11)		26.2 (16)	51.9 (42)	
>4	2.7 (1)	0.0 (0)		14.8 (9)	3.7 (3)	
Actual months of severe food shortages						
January	0.0 (0)	3.7 (1)		4.9 (3)	6.2 (5)	
February	2.7 (1)	3.7 (1)		6.6 (4)	6.2 (5)	
March	24.3 (9)	14.8 (4)		21.3 (13)	22.2 (18)	
April	27.0 (10)	14.8 (4)		42.6 (26)	53.1 (43)	
May	54.1 (20)	40.7 (11)		77.1 (47)	75.3 (61)	
June	67.6 (25)	85.2 (23)		67.2 (41)	71.6 (58)	
July	40.5 (15)	48.2 (13)		41.0 (25)	25.9 (21)	
August	2.7 (1)	3.7 (1)		4.9 (3)	1.2 (1)	
September	0.0 (0)	0.0 (0)		0.0 (0)	1.2 (1)	
October	0.0 (0)	0.0 (0)		0.0 (0)	0.0 (0)	
November	0.0 (0)	0.0 (0)		1.6 (1)	0.0 (0)	
December	0.0 (0)	3.7 (1)		1.6 (1)	0.0 (0)	

[1]Semi-urban sites were closer to major urban centers, had easier access to major roads, and had more community infrastructure.
[2]Analyses used Student's t-test for continuous variables and Chi-square or Fischer's exact test for categorical variables. [3] Mean ± SEM [4]% (n)

Table 4. 24-hour household diet diversity score in intervention and control communities for the Central Region of Ghana (coastal)

Foods Consumed	Rural			Semi-urban[1]		
	Intervention N=37	Control N=27	P-value[2]	Intervention N=61	Control N=81	P-value
Cereal based	91.9 (34) [3]	100.0 (27)	0.2567	96.7 (58)	98.8 (79)	0.5764
Roots and tubers	73.0 (27)	70.4 (19)	0.8191	47.5 (29)	75.0 (60)	0.0008
Vegetables	78.4 (29)	96.3 (26)	0.0670	76.7 (46)	80.0 (64)	0.6343
Fruits	59.5 (22)	59.3 (16)	0.9872	27.9 (17)	27.5 (22)	1.0000
Pulses and nuts	32.4 (12)	33.3 (9)	0.9396	27.9 (17)	47.5 (38)	0.0179
Livestock, bush meats and poultry	2.7 (1)	33.3 (9)	0.0012	3.3 (2)	5.0 (4)	0.6982
Eggs	32.4 (12)	37.0 (10)	0.7017	15.0 (9)	16.3 (13)	0.8406
Fish and shellfish	86.5 (32)	92.6 (25)	0.6890	91.7 (55)	88.8 (71)	0.5692
Milk and milk productions	5.4 (2)	22.2 (6)	0.0612	13.1 (8)	7.5 (6)	0.2694
Foods made with oils	54.1 (20)	74.1 (20)	0.1023	50.8 (31)	51.3 (41)	0.9596
Sugar or honey	62.2 (23)	74.1 (20)	0.3162	47.5 (29)	50.0 (40)	0.7723
Condiments and beverages	10.8 (4)	29.6 (8)	0.1024	16.4 (10)	4.9 (4)	0.0432
Diet diversity score[4]	5.89 ± 0.34[5]	7.22 ± 0.46	0.0204	5.11 ± 0.25	5.5 ± 0.19	0.2362

[1]Semi-urban sites were closer to major urban centers, had easier access to major roads, and had more community infrastructure.
[2]Analyses used Student's t-test for continuous variables and Chi-square or Fischer's exact test for categorical variables.
[3]Maximum summed diet diversity score=12 [4]Mean ± SEM

Table 5. Household use and source of different animal source foods (ASF) in last week in intervention and control communities for the Central Region of Ghana (coastal)

ASF	Rural			Semi-urban[1]		
	Intervention	Control	P-value[2]	Intervention	Control	P-value
Beef	10.8 (4) [3]	14.81 (4)	0.7119	3.33 (2)	2.47 (2)	1.0000
Purchased	100.0 (4)	100.0 (4)		100.0 (2)	100.0 (2)	
Home produced						
Pork	0.0 (0)	0.0 (0)		1.64 (1)	0.0 (0)	0.4296
Purchased				100 (1)		
Home produced						
Sheep	5.41 (2)	0.0 (0)	0.5045	4.92 (3)	0.0 (0)	0.0770
Purchased	100 (2)			66.7 (2)		
Home produced						
Other				33.3 (1)		
Goat	2.70 (1)	14.81 (4)	0.1529	3.28 (2)	8.64 (7)	0.3002
Purchased		25.0 (1)			71.4 (5)	
Home produced	100.0 (1)	75.0 (3)		50.0 (1)	14.3 (1)	
Other				50.0 (1)	14.3 (1)	
Rabbit	0.0 (0)	0.0 (0)		0.0 (0)	0.0 (0)	
Purchased						
Home produced/hunted						
Other						
Grasscutter	0.0 (0)	0.0 (0)		3.28 (2)	14.81 (12)	0.0224
Purchased				50 (1)	25.0 (3)	
Home produced/hunted				50 (1)	66.7 (8)	
Other					8.3 (1)	
Other bush meats	0.0 (0)	0.0 (0)		1.64 (1)	18.52 (15)	0.0016
Purchased					6.7 (1)	
Home produced/hunted				100.0 (1)	93.3 (14)	
Other						
Poultry	32.43 (12)	40.74 (11)	0.4939	13.11 (8)	7.41 (6)	0.2588
Purchased	45.5 (5)	81.8 (9)		62.5 (5)	33.3 (2)	
Home produced	54.6 (6)	9.1 (1)		25.0 (2)	33.3 (2)	
Other	0.0 (0)	9.1 (1)		12.5 (1)	33.3 (2)	
Snails	5.41 (2)	7.41 (2)	1.0000	9.84 (6)	35.80 (29)	0.0004
Purchased	100.0 (2)	100.0 (2)		33.3 (2)	10.3 (3)	
Home produced				66.7 (4)	82.8 (24)	
Other					6.9 (2)	
Eggs	40.54 (15)	92.6 (25)	<0.0001	36.07 (22)	29.63 (24)	0.4172
Purchased	60.0 (9)	72.0 (18)		77.3 (17)	70.8 (17)	
Home produced	33.3 (5)	24.0 (7)		22.7 (5)		
Other	6.7 (1)	4.0 (1)				
Fresh fish	91.89 (34)	100 (27)	0.2567	91.8 (56)	84.0 (68)	0.1638
Purchased	18.2 (6)	29.6 (8)		80.5 (45)	98.5 (67)	
Home produced	75.8 (25)	66.7 (18)		8.9 (5)	1.5 (1)	
Other				10.7 (6)		
Smoked/dried fish	72.97 (27)	66.67 (18)	0.5855	80.33 (49)	91.36 (74)	0.0560
Purchased	51.9 (14)	66.7 (12)		89.8 (44)	96.0 (71)	
Home produced	48.2 (13)	22.2 (4)		8.2 (4)	2.7 (2)	
Other		11.1 (2)		2.0 (1)	1.4 (1)	
Shell fish	78.38 (29)	77.78 (21)	0.9542	72.13 (44)	20.99 (17)	<0.0001
Purchased	17.2 (5)	38.1 (8)		69.1 (29)	94.1 (16)	
Home Produced	75.9 (22)	52.4 (11)		21.4 (9)	5.9 (1)	
Other	9.5 (2)	6.9 (2)		9.5 (4)		
Milk	21.62 (8)	44.44 (12)	0.0517	24.59 (15)	6.17 (5)	0.0018
Purchased	100.0 (8)	100.0 (12)		86.7 (13)	100.0 (5)	
Home produced						
Other				13.3 (2)		
Milk Products	2.70 (1)	18.52 (5)	0.0748	4.92 (3)	2.47 (2)	0.6515
Purchased	100.0 (1)	100.0 (5)		100.0 (3)	100.0 (2)	
Home Produced						
Other						
Insects	0.0 (0)	0.0 (0)		0.0 (0)	0.0 (0)	
Purchased						
Home Produced						
Other						

[1]Semi-urban sites were closer to major urban centers, had easier access to major roads, and had more community infrastructure.
[2]Analyses used Chi-square or Fischer's exact test for intervention-control comparisons of use of individual ASF.
[3] % (n)

Table 6. Consumption and frequency of consumption of different animal source foods by the reference 2- to 5-y-old children during the last week, in intervention and control communities for the Central Region of Ghana (coastal)

	Rural			Semi-urban[1]		
	Intervention N=37	Control N=27	P-value[2]	Intervention N=61	ControlN=81	P-value
Beef	5.4 (2) [3]	14.8 (4)	0.2307	6.7 (4)	4.9 (4)	0.7251
Pork	0.0 (0)	0.0 (0)		1.9 (1)	1.2 (1)	1.0000
Sheep	5.4 (2)	0.0 (0)	0.5045	4.9 (3)	0.0 (0)	0.0770
Goat	13.5 (5)	11.1 (3)	1.0000	4.9 (3)	9.9 (8)	0.3516
Rabbit	0.0 (0)	0.0 (0)		3.3 (2)	1.2 (1)	0.5770
Grasscutter	0.0 (0)	0.0 (0)		3.3 (2)	14.8 (12)	0.0244
Other bushmeat	0.0 (0)	0.0 (0)		1.6 (1)	22.2 (18)	0.0004
Poultry	24.3 (9)	40.7 (11)		16.4 (10)	9.9 (8)	0.2479
Snails	5.4 (2)	7.4 (2)	1.0000	18.0 (11)	38.3 (31)	0.0089
Eggs	51.4 (19)	92.6 (25)	0.0004	41.0 (25)	30.9 (25)	0.2114
Fresh fish	97.3 (36)	100.0 (27)	1.0000	96.7 (59)	91.4 (74)	0.3002
Smoked/dry fish	75.7 (28)	77.8 (21)	1.0000	86.9 (53)	95.1 (77)	0.1259
Shell fish	80.6 (29)	85.2 (23)	0.7446	78.7 (48)	19.8 (16)	<0.0001
Milk	35.1 (13)	51.9 (14)	0.1811	21.3 (13)	7.4 (6)	0.0160
Milk products	5.4 (2)	25.9 (7)	0.0291	9.8 (6)	1.2 (1)	0.0423
Insects	0.0 (0)	0.0 (0)		0.0 (0)	0.0 (0)	

[1]Semi-urban sites were closer to major urban centers, had easier access to major roads, and had more community infrastructure.
[2]Analyses used Chi-square or Fischer's exact test for intervention-control comparisons of use of individual ASF. [3] % (n)

Table 7. Characteristics of reference children in intervention and control communities for the Central Region of Ghana (coastal)

	Rural			Semi-urban[1]		
	Intervention N=37	Control N=27	P-value[2]	Intervention N=61	Control N=81	P-value
Age (mo)[3]	41.3 ± 1.4[4]	37.6 ± 2.2	0.1627	39.7 ± 1.40	37.8 ± 1.1	0.2946
≥24-36	28.1 (9)[5]	41.7 (10)	0.5432	36.2 (21)	48.7 (36)	0.3537
>36-48	53.1 (17)	45.8 (11)		43.1 (25)	33.8 (25)	
>48-60	18.8 (6)	12.5 (3)		20.7 (12)	17.6 (13)	
Sex						
Male	51.4 (19)	37.0 (10)	0.2559	48.3 (29)	50.0 (37)	0.8478
Female	48.6 (18)	63.0 (17)		51.7 (31)	50.0 (37)	
Anthropometry[6]						
WHZ	-0.23 ± 0.15	-0.56 ± 0.13	0.1152	-0.23 ± 0.11	-0.54 ± 0.09	0.0287
>-2 Z-scores	97.3 (36)	100 (27)	0.5781	98.3 (59)	98.7 (77)	1.000
≤-2 Z-scores	2.7 (1)	0.0 (0)		1.7 (1)	1.3 (1)	
WAZ	-0.89 ± 0.20	-1.03 ± 0.20	0.6360	-0.97 ± 0.14	-1.44 ± 0.12	0.0108
>-2 Z-scores	83.9 (26)	79.2 (19)	0.7325	86.0 (49)	68.5 (50)	0.0204
≤-2 Z-scores	16.1(5)	20.8 (5)		14.0 (8)	31.5 (23)	
HAZ	-1.14 ± 0.21	-0.92 ± 0.24	0.4896	-1.22 ± 0.17	-1.57 ± 0.15	0.1311
>-2 Z-scores	83.9 (26)	88.5 (23)	1.0000	71.9 (41)	61.1 (44)	0.1980
≤-2 Z-scores	16.1 (5)	11.5 (3)		28.1 (16)	38.9 (28)	

[1] Semi-urban sites were closer to major urban centers, had easier access to major roads, and had more community infrastructure.
[2] Analyses used Chi-square or Fischer's exact test for intervention-control comparisons of use of individual ASF.
[3] Missing child age for: n=3-rural control; n= 5-rural intervention; n=7- semi-urban control; n= 3 semi-urban intervention. [4]Mean ± SD
[5] % (n) [6] Flagged data (> 4 SD or missing age) were not included.

Central Region The coastal intervention communities selected are: Nsuakyir (Ewutu-Effutu-Senya District; semi-urban) and Warabeba (Ewutu-Effutu-Senya District, rural) and the control communities are: Kwaekrom (Gomoa District, control for Nsuakyir) and Akosua Village (Ewutu-Effutu-Senya, control for Warababa). The preliminary analyses of the baseline characteristics are shown in Tables 1-7. Compared to the control site, the rural intervention site had a higher proportion of Akan, practiced more tree-cropping, and had less diversity in the diet. In the semi-urban the intervention as compared to the control site, fewer residents were Akan and Christian, they were more likely to fish or sell fish, process foods, be a laborer, or have a salaried job, they were less likely to live on family land and experience food shortages, and their children had better nutritional status.

Intervention site - Warababa. Information was obtained through observations and key-informant interviews with 7 key informants (3 women and 4 men) made up of chief fishermen and leading fishmongers (women) in the community. The community of about 500 people is comprised of a strip of housing units (2-3 rows) bordered by the ocean (Atlantic) on one side and marshland with mangrove vegetation on the other side. Warababa is separated from its nearest neighboring community (Nsuakyir) by a lagoon. The community is presided over by a chief. The main occupation in the community is fishing. The men fish and the women sell the fish.

a. Infrastructure. The chief of the community and the Baptist church own water tankers and periodically bring water for sale to the community. Community members also purchase water from a nearby village for drinking and cooking at about 11 cents per bucket. Households use an average of about 5 buckets of water a day. Water from a nearby stream is used for washing clothes and for bathing. There is no electricity in the community. Kerosene lanterns and flashlights are used. There are no toilet facilities (private or public) in the community; residents use the nearby marshland.

There is one major road to Warababa. It is a tractor prepared road but currently not tarred and joins a paved road to Winneba (closest city). The road is accessible throughout the year. Residents use taxis and trotros (mini-vans) for travel. These come infrequently to Warababa, however residents can walk to Nsuakyir where transportation is more readily available.

There is no health facility within the community; the community uses health facilities in Winneba about 4 miles. There is an herbalist. Community health nurses (from Ghana Health Services) periodically come to the community for growth monitoring of children and immunizations. No other institutions have been involved in nutrition or health-related activities in the community.

There is no school in the community. Children in the community attend primary school at Nsuakyir. Nsuakyir is about 1.5 miles from Warababa. There is a Baptist church in the community.

There is no market. There is one table-top store where a few basic items such as sugar, gari (cassava), bread, fresh pepper are sold. Winneba is the nearest major market and is about one-hour walk from Warababa; transportation cost from Warababa to Winneba is 44 cents.

b. Food security. No food crops are grown in the community. The main staples consumed are cassava, corn, and rice and they are purchased and more difficult to obtain in May and June due to low incomes related to these months being out-of-season for fishing. The primary ASF consumed is fish. Peak fishing season is from July to September but fish is consumed year round. Chicken is also consumed but usually during festivities. There are no communal silos or storage banks for grain, other food crops, or ASF. There are no commercial food processing activities except for a salt factory within walking distance. There is a non-operational corn-mill (owner lives outside the community). Individual fish mongers salt or smoke fish for preservation for sale. There are no community-wide food prohibitions for pregnant or lactating women or children but food prohibitions may exist at the household level.

Presently there is no access to veterinary services through MOFA.

c. Associations or formed groups. There is only one formed group of women in the community that is a welfare support group. (Table 8).

Intervention site - Nusakyir. Information was

Table 8. Intervention Site, Warababa. Associations or formed groups.

Name of Groups	Purpose of groups
Eme Nyame uye obeyeyie women's group	Welfare group to support members in times of difficulty
Men's Fellowship (Baptist Church)	Marriage counseling; HIV / AIDS education
Men's Fellowship (Pentecost)- located at Nsuakyir	Support group for developing sense of responsibility towards our wives and children
Gyadzo Mozama Disco Christo Church - located at Nsuakyir	Teaching on loving one another

obtained through observations and key-informant interviews with 11 key informants (6 women and 5 men) made up of assembly man and leading family heads in the community. The leading family heads were chosen by the community leaders and the project contact person. The community lies 1 mile away from Warababa and north of the coast of the Atlantic Ocean. This community is presided over by a chief. The main occupation in the community is farming but some of the inhabitants go to the sea side for fishing activities.

a. Infrastructure. There are about 4 piped-borne water stands situated in individual homes throughout the community. There are a number of hand-dug wells which are also used for drinking and cooking purposes. Piped-water for drinking could be purchased at a cost of 2 cents per bucket and about 20 cents is spent on purchased water per day per household. The lagoon nearby is used for bathing and washing. Although there is electricity in the community, only about 50-60 out of 184 homes have it and there are no street lights. The rest of the homes use kerosene lanterns and flashlights. The community has a public toilet facility built by the district assembly.

There is one major road from Winneba that passes through the community and is accessible throughout the year. There are a number of taxis and trotros (mini-vans) that are used for private as well as commercial travels. Winneba is about 3 miles from Nsuakyir, between 45-60 minutes walking.

There is no health facility; the community goes to Winneba for major health needs. The Ghana Health Service, through the community health delivery programs, periodically comes for growth monitoring and immunizations. Community health nurses also give talks on children's foods, treatment of minor ailments, and care for the elderly.

There is a nursery school, primary school and a JSS (junior high) school. The nursery school was built and is also being supported by Plan International but the primary and the JSS are government-assisted schools. The community has no access to extension or veterinary services.

There is a small market in addition to a few table-tops and about 4 kiosks for the sale of items such as sugar, gari (cassava) and soap. The nearest major markets are in Winneba, Swedru, and Kasoa. During market days, goods are bought in bulk from these markets for retail within the community. Transportation costs from Nsuakyir to the three main markets are: Nsuakyir/ Winneba—33 cents, Nsuakyir/ Swedru—73 cents, and Nsuakyir/ Kasoa —67 cents.

b. Food Security. The main staples consumed are corn, cassava, plantain, cocoyam and yam. With the exception of corn and cassava, all staples that are consumed are purchased because they are not commonly grown within the community. Difficult months for obtaining the main staples for consumption are: May – July and September – February. The primary ASF consumed is fish. The peak period for increased consumption of fish is August to December. Although fish is consumed year round, it becomes expensive during the lean season.

There are no communal silos or storage banks for grain, other food crops or ASF. Individuals store their own foods within their compounds. There are no commercial food processing activities except for a couple of small-scale cassava drying (for kokonte), gari processing and smoking and drying of fish on an individual basis.

There are no community-wide food prohibitions for pregnant or lactating women or children. Food prohibitions may exist at the household level.

c. Associations. There are 2 women's groups – one to establish savings for member-traders and one welfare group. (Table 9).

Table 9. Intervention site, Nsuakyir. Associations or formed groups.

Name of group	Purpose of group
Market women's group	Establish savings to assist member-traders during emergencies/ difficult times
Church women's group / Choir	Welfare / benevolence

Control site - Kwaekrom. The information was obtained through observations and key-informant interviews with 8 key informants (4 women and 4 men) made up of the chief, his elders, and other opinion leaders chosen by the chief. The community is about 2000 residents and located within the administrative boundaries of the Gomoa district, which lies to the southwest of the Awutu Efutu Senya district of the Central region. It is a control community for Nsuakyir. It is largely a farming community and presided over by a chief.

a. Infrastructure. The community relies on 3 wells for bathing and washing and a water tanker service for their drinking and cooking needs. Water is purchased from the tanker by some dealers, stored in water reservoirs and retailed to community members at a cost of 16 cents per bucket (note: confirmation of this put the actual cost at 11 cents). On average, households use about $2.00-2.20/d in water. The community does not have electricity. Most of the people use a kerosene lantern. There are no toilet facilities (private or public) (note: confirmation of this found that 4 households had a KVIP).

There is one major road (partly tarred) that stretches from Winneba. The road is full of potholes and may not be passable during the rainy season. Walking becomes the only option. Transit vehicles usually pick up commuters.

There is no health facility within the community. Residents in this community use government health facilities in Winneba for major health needs. Winneba is about 9 miles from Kwaekrom. Irregular transport appears to be a hindrance to accessing health services. The Ghana Health Service, through the community health delivery programs periodically come to do immunizations, weigh children and educate caregivers on child nutrition. There are other organizations (e.g., ADRA and the Game and Wild Life) which have collectively helped the community to be more conscious about their environment.

There is a day nursery school, primary and JSS in the community. The day nursery receives support from the Women's fellowship of the GHACOE but the primary and the JSS are government-assisted schools. The community does not have access to veterinary services.

There is a local market in addition to few table-top sales points. The local market and the stores open daily for the sale of petty items but on specific market days, traders travel to nearby towns like Winneba and Kasoa to do bulk purchases for retail within the community. Transportation from Kwaekrom to Kasoa ranges between 56-67 cents.

b. Food Security. The main staples consumed are corn, cassava, plantain and yam. However, the plantain and yam are not commonly produced in the community. Difficult months for obtaining the main staples for consumption appear to stretch April through to August.

The primary ASF consumed in the community is fish. Peak period for increased consumption of fish in the community is from April through to October. Bush meat is also available from August to December when the vegetation is dry (Hamattan) and people can hunt.

There are no communal silos or storage banks for grain, other food crops, or ASF. Individuals store their own foods within their compounds. No commercial food processing activities in the community except for some few individuals who do smoke fish and bush meat on small scale basis.

Table 10. Control site, Kwaekrom. Associations or formed groups.

Name of group	Purpose of group
Palace group	Advocacy for the community
Welfare group	Benevolence for members
Town development group	Community beautification and hygiene
Cashew farmers association	Cashew production
Church group	Advocacy on social issues

No community-wide food prohibitions for pregnant or lactating women or children. Food prohibitions may exist at the household level.

c. Associations. The church group has a women's group separate from that of men, and is responsible

for settling disputes and visiting the sick. The other groups are mixed. (Table 10).

Control site - Akosua Village. The information on this village of about 600 residents was obtained through observations and key-informant interviews with 4 key informants (1 woman and 3 men) made up of community chief, the chairman and secretary of the unit committee and other members who know the community very well. The community is structured like a strip of housing units extending immediately on the south-western side of the Winneba town and also lying along the ocean (Atlantic). Akosua village is divided into two sections along the stretch by the premises of the Ghana Police Service Training School, Winneba. The survey included the community on the western side of the training school. The community is presided over by a chief and unit committee members. The main occupation in the community is fishing. The men fish and the women sell the fish.

a. Infrastructure. The community has pipe-borne water, which is accessible throughout the year. There is no electricity; kerosene lanterns and flashlights are used. There is no functional private or public toilet facility.

There is one major strip of road that leads from Winneba into Akosua village and back. It is basically a beach community and very difficult to drive through the community due to the thick loose sand. The community is however accessible by road all year round. Although taxis travel the road, some travelers walk up to Winneba for transport to their destinations.

With the exception of traditional birth attendants, there are no other health facilities within the community. The government hospital and three other private clinics in Winneba are used by the community members. Akosua village is about 1.5 miles from Winneba. Community health nurses (from Ghana Health Services) periodically come to the community to weigh and assess the growth of the children as well as conduct immunizations.

There is no school; children attend schools in Winneba. Personnel of the veterinary services of the MOFA visit the community periodically to check and medicate their animals.

There is no market in the community. There are table-top stores where a few basic items such as sugar, gari, bread, cooked food, fruits and snacks are sold. The nearest major markets to the community are Winneba, Nkwantanan, Swedru and Kasoa. Transportation cost from Winneba to Swedru is 44 cents and from Winneba to Kasoa is 78 cents.

b. Food Security. The main staples consumed are corn, rice, yam, cassava, plantain and cocoyam. No food crops are grown in the community. All staples that are consumed are purchased. Difficult months for obtaining the main staples for consumption are May – July and November - January. The primary ASF consumed in the community is fish. Peak fishing season is from August to September. However, beef and poultry products are consumed all year round.

There are no communal silos or storage banks for grain, other food crops, or ASF. Individuals store their own foods within their compounds. For instance, cement paper is used by individuals to package and store smoked fish in special ways. There are a few commercial food processing activities in the community. These include salting, drying and smoking of fish as well as milling of maize and the extraction of coconut oil.

There are no community-wide food prohibitions for pregnant or lactating women or children. Food prohibitions may exist at the household level.

c. Associations. There are no women's groups in the community (a fishmonger's association has dissolved), only one youth group.

Brong-Ahafo Region. The communities in the Techiman municipality included the intervention sites of Forikrom (semi-urban) and Fiaso (rural) and the control communities of Nkaeso (match for Forikrom) and New Techiman (match for Fiaso). Data were collected from July 28 to August 18, 2005. The residents of the rural intervention site had a lower diversity in diet than the control site but child nutritional status was similar. Semi-urban sites were similar.

Intervention site - Forikrom. Information obtained through observations and key-informant interviews with 9 key informants (all men) made up of the chief, his elders/ counsel including some unit committee members. A unit committee is

Table 11. 24-hour household diet diversity score in intervention and control communities for the Brong-Ahafo Region of Ghana (central forest belt)

Foods Consumed	Rural			Semi-urban[1]		
	Intervention N=213	Control N=160	P-value[3]	Intervention N=197	Control N=162	P-value
Cereal based	92.4 (194)[2]	95.6 (152)	0.2056	89.3 (176)	96.1 (146)	0.0200
Roots and tubers	94.8 (199)	96.9 (154)	0.3282	95.9 (189)	96.1 (146)	0.9573
Vegetables	92.9 (195)	95.6 (152)	0.2709	97.0 (191)	89.5 (136)	0.0044
Fruits	23.3 (49)	31.5 (50)	0.0815	16.2 (32)	36.8 (56)	<0.0001
Pulses and nuts	29.1 (61)	49.1 (78)	<0.0001	26.9 (53)	29.0 (44)	0.6726
Livestock, bush meats and poultry	45.7 (96)	28.3 (45)	0.0007	45.7 (90)	32.2 (49)	0.0109
Eggs	25.2 (53)	34.6 (55)	0.0505	26.9 (53)	27.0 (41)	0.9883
Fish and shellfish	81.0 (170)	88.1 (140)	0.0654	89.9 (177)	90.8 (138)	0.7686
Milk and milk productions	12.4 (26)	12.0 (19)	0.9002	8.1 (16)	6.7 (10)	0.5863
Foods made with oils	53.8 (113)	66.0 (105)	0.0180	55.8 (110)	59.2 (90)	0.5276
Sugar or honey	58.1 (122)	62.3 (99)	0.4184	51.3 (101)	57.9 (88)	0.2181
Condiments and beverages	19.1 (40)	10.7 (17)	0.0279	15.2 (30)	21.7 (33)	0.1185
Diet diversity score[4]	6.3 ± 2.0[5]	6.7 ± 1.8	0.0351	6.2 ± 1.6	6.4 ± 1.9	0.3287

[1] Semi-urban sites were closer to major urban centers, had easier access to major roads, and had more community infrastructure. *[2] % (n)*
[3] Analyses used Student's t-test for continuous variables and Chi-square or Fischer's exact test for categorical variables.
[4]Maximum summed diet diversity score=12 *[5] Mean ± SEM*

Table 12. Characteristics of reference children in intervention and control communities for the Brong-Ahafo Region of Ghana (central forest belt)

	Rural			Semi-urban[1]		
	Intervention N=213	Control N=160	P-value[2]	Intervention N=197	Control N=162	P-value
Age (mo)	40.3 ± 0.68[3]	40.5 ± 0.82	0.8681	41.1 ± 0.75	42.8 ± 0.81	0.1125
≥24-36	36.9 (75)[4]	38.3 (59)	0.7997	35.6 (69)	27.7 (41)	0.2340
>36-48	38.4 (78)	35.1 (54)		35.6 (69)	36.5 (54)	
>48-60	24.6 (50)	26.6 (41)		28.9 (56)	35.8 (53)	
Sex						
Male	52.4 (109)	41.9 (65)	0.0483	47.2 (93)	55.9 (85)	0.1064
Female	47.6 (99)	58.1 (90)		52.8 (104)	44.1 (67)	
Anthropometry[5]						
WHZ	-0.25 ± 0.07	-0.12 ± 0.05	0.2187	-0.16 ± 0.09	0.09 ± 0.14	0.1198
>-2 Z-scores	98.4 (190)	99.4 (158)	0.6299	98.2 (167)	98.6 (139)	1.0000
≤-2 Z-scores	1.5 (3)	0.6 (1)		1.7 (3)	1.4 (2)	
WAZ	-1.08 ± 0.06	-1.08 ± 0.07	0.9856	-1.01 ± 0.07	-0.83 ± 0.11	0.1772
>-2 Z-scores	80.3 (163)	84.4 (130)	0.3148	84.0 (163)	85.2 (126)	0.7778
≤-2 Z-scores	19.7 (40)	15.6 (24)		15.9 (31)	14.9 (22)	
HAZ	-1.45 ± 0.08	-1.60 ± 0.11	0.2840	-1.38 ± 0.11	-1.32 ± 0.14	0.7659
>-2 Z-scores	65.1 (121)	64.9 (100)	0.9818	66.5 (111)	71.0 (98)	0.3947
≤-2 Z-scores	34.9 (65)	35.1 (54)		33.5 (56)	28.9 (40)	

[1]Semi-urban sites were closer to major urban centers, had easier access to major roads, and had more community infrastructure.
[2]Analyses used Chi-square or Fischer's exact test for intervention-control comparisons of use of individual ASF.
[3]Mean ± SD
[4] % (n)
[5]Flagged data (> 4 SD or missing age) were not included.

a sub-body under the district assembly structure comprised of a body of selected members with executives to help bring about development within the community. The community is about 4000 residents with about 500 households. Forikrom is an old settlement mainly populated by peasant farmers. The community lies at the eastern side of the Techiman township about 5 miles along the Techiman – Nkoranza major road. The community is presided over by a chief.

a. Infrastructure. The community has the following sources of water for their domestic use: 2 bore-holes, 1 solar-powered well and 2 hand-dug wells. There is also a near-by stream which the inhabitants use for drinking, cooking, and washing. There is no electricity in the community. Kerosene lanterns, flashlights and car batteries are the major sources of light. Although the major road to the community is good, lack of drains will not make it last. There are no access roads to farms thereby making it difficult for residents to cart their farm wares home.

Residents use taxis and other passing mini-buses to travel; there are 8 taxis resident.

There is a community health centre and 6 traditional birth attendants in the community, working under the supervision of the Ghana Health Service. There are also 10 traditional herbalists and 1 fetish priest. The community sometimes travel 5 miles to Techiman for medical attention either at the government hospital or the Ahmediyah hospital. Community health nurses (from Ghana Health Services) periodically organizes maternal and child weighing sessions in the community. The Obaapa Vitamin A supplementary program being sponsored by the WHO is also operational in the community. ADRA has also trained people in the community to educate lactating mothers on health and nutrition issues in the community. These are done through educational talks in churches.

The community has three day-care schools; three primary schools; and two junior secondary schools. For both the day-care and the primary schools, 1 in each case is owned by a private individual, and the rest in addition to the JSS are owned by the government. Within the community, children would usually walk to school. Children in senior secondary schools mostly go to nearby communities like Techiman (5 miles), Aworowa (10 miles), Wenchi (23 miles) and Tuobodom (9 miles). MOFA veterinary personnel are on schedule to visit and attend to the community's veterinary needs but they do not visit as scheduled, waiting to accumulate requests. Fee for the consultations ranges from 56 cents to $1.11 per animal attended.

There is a small market within the community. This is opened every day for the sale of provisions and other items including food stuffs. There are also table-top stores in few individual homes but key informants also disclosed that some of the farmers arrange to sell their wares in their homes in bulk to traders from Techiman and beyond. Transportation cost from Forikrom to Techiman, the nearest major market is 28 cents. People sometimes use bicycle or walk to Techiman (10 - 60 minutes). Some traders go to communities like Bupei (northern region) and Yeji (Brong-Ahafo region) to buy fish to bring to sell in the community.

b. Food Security. The main staples consumed are cassava, yam, plantain, cocoyam and maize. All the staple foods crops are grown in the community. Difficult months for obtaining the main staples for consumption are March through to July. The primary ASF consumed is fish; bush meat and livestock/ poultry are also consumed but on occasional basis. There is a warehouse which is owned and managed by a community-based organization in the community, known as ABOFAP. It was constructed with the assistance of the Village Infrastructure Project (VIP). It is used for the storage of dry maize and yams. Majority of individuals still store their wares at their various homes but traders and individuals alike patronize the service at a fee.

No community-wide food prohibitions for pregnant or lactating women or children. Food prohibitions may exist at the household level for religious and other personal reasons.

c. Associations. There are no specific women's groups but women participate in the associations listed in Table 13.

Intervention site – Fiaso. The information for this town of about 5000 with about 600 households was obtained through observations and key-informant interviews with 5 key informants (3 men

Table 13. Intervention site, Forikrom. Associations or formed groups.

Name of group	Purpose of group
ABOFAP	Farmer-to-farmer extension in organic farming, bee-keeping and inventory credit
Watch-dog committee	Security for the community during the night against thieves
Reforestation volunteers	Forestation and government policy on forestry
Forikrom community-based extension services (FOCOBES)	Receive extension training from ABOFAP to train other farmers

and 2 women) comprising the chief, the acting queen mother, and the chairman of the unit committees. Fiaso is a settler community mainly populated by migrant peasant farmers. The community lies about 3 miles away from Forikrom along the Techiman – Nkoranza major road. The community is presided over by a chief.

a. Infrastructure. The community has 2 bore-holes which they use for drinking and other domestic purposes. The community received 90% construction sponsorship from the World Bank, 5% contribution from the district assembly and the remaining 5% by the community itself. There are two near-by streams which the inhabitants use also for cooking and washing. There is no electricity; however, they have three solar panels: one each for use by the clinic, adult education class and the JSS unit. Households use lantern in kerosene lanterns, flashlights and car batteries (for television) are the major sources of energy and light for the community. The major road to the community is good, roads within the community are very bad with pot holes and also lack defined vehicular lanes. Residents use taxis and other passing mini-buses to travel into and out of the community. Transport fares from Fiaso to Techiman are 33 cents for the mini bus and 44 cents for taxis.

There is a CHPS centre (Community Health Promotion Service) and 5 traditional birth attendants in the community, working under the supervision of the Ghana Health Service. There are also 3 traditional healers. The community members sometimes travel either 3 miles to Forikrom or 9 miles to Techiman for medical attention. The CHPS Centre (Ghana Health Services) periodically organizes child weighing sessions, including the sale of improved children's feed. The centre also conducts disease prevention and sanitation education campaigns. The Obaapa Vitamin A supplementary program being sponsored by the WHO is been carried out in the community.

The community has a day-care centre, owned by the community. It also has another school, which is owned by the government with nursery, primary, and JSS facilities. Children in senior secondary schools mostly go to nearby communities like Techiman (9 miles), Aworowa (14 miles), and Tuobodom (13 miles). MOFA veterinary personnel visit the community almost every two weeks from Techiman to attend to sick animals. Individuals who employ the services of veterinary officer provide a token fee to cover transportation of the office.

There is a small but active market within the community. This is opened every day for the sale of provisions and other items including food stuffs. There are also kiosks and table-top stalls in few individual homes; some of the farmers arrange to sell their wares in their homes in bulk to traders from Techiman and beyond. The community also has a market shed by the roadside which provides market opportunity for the foodstuff traders in the community to sell their wears to travelers along the main road. Transportation cost from Fiaso to Techiman, the nearest major market is 44 cents and the travel time is about 15 minutes.

b. Food Security. The main staples consumed are maize, cassava, yam, cocoyam and plantain. All the staple food crops are grown in the community. Difficult months for obtaining the main staples for consumption are April-May and to August to November. The primary ASF consumed is fish; livestock and poultry products are consumed but on occasional basis, especially during festive periods. Fish is consumed all year round both in fresh and smoked form. Individuals store their wares at their homes.

There are no community-wide food prohibitions for pregnant or lactating women or children. Food prohibitions may exist at the household level for religious and other personal reasons.

c. Associations. There are no specific women's groups.

Table 14. Intervention site, Fiaso. Associations or formed groups.

Name of group	Purpose of group
Anitenfi group (Assisted by EPA)	Prevention of bush fires through teak and cashew plantation
Potato / Tomato farmers group	To seek financial assistance to members
ADOKONO	Teach about organic farming and the use of organic manure

Control site – Nkwaeso. Information about this community of about 3000 residents obtained through observations and key-informant interviews with 4 key informants (2 women and 2 men) made up of the representative of the chief and other community opinion leaders. This is a farming community and is presided over by a chief. The community is about 5 km from Techiman along the Techiman-Sunyani major road.

a. Infrastructure. The community has a bore-hole that is used for drinking; a bucket is sold for 1 cent. There are also two hand-dug wells in the community, which sell at 0.5 cents per bucket. The hand-dug well is used for cooking and washing. In addition, there are two streams nearby the community that people sometimes use for other domestic purposes. The community has electricity but about 15% of the houses do not have electricity. Most of the people use lanterns which are fueled by kerosene. There is one community pit latrine. Some individuals have their own latrines.

The tarred major road leading from Techiman to Sunyani passes through the community. Roads leading to neighboring villages are not tarred and difficult when it rains. There is a small transport station. There are also transit vehicles which pick up commuters. Transportation from the community to Techiman is 22 cents (taxi) or 17 cents (minibus). People also walk or use bicycles.

There are 4 traditional birth attendants (TBAs); people usually travel to Techiman to access health facilities. Community health nurses (GHS), through their outreach programs, come to the community once a month to do immunizations, weigh children, and educate caregivers on child nutrition.

There is a day nursery school, 2 kindergartens, 2 primary and 1 junior secondary school. These schools are all within walking distances in the community. The community does not have a senior secondary school so people usually go to the ones in Techiman and other neighboring towns. The community does not have regular access to veterinary services. The MOFA officer arranges a visit occasionally to attend to problems.

There is a small local market in addition to about 21 kiosks in the community. The local market and the stores open daily for the sale of petty items but on specific market days, traders travel to Techiman to do bulk purchases for retail within the community.

b. Food Security. The main staples consumed are cassava, plantain, cocoyam, yam and plantain. All the major staples are produced in the community. Difficult months for obtaining the main staples for consumption are February-April and June-July. The primary ASF consumed in the community are fish, beef and chicken in the order of the most commonly consumed.

There are no communal silos or storage banks for grain, other food crops or ASF. Individuals store their own foods within their compounds. No large scale food processing activities in the community except for some few individuals who do gari processing on small scale basis.

There are no community-wide food prohibitions for pregnant or lactating women or children.

c. Associations. There is an organization (Sinapi Aba) in the community. It provides women and men with micro-finance credit to engage in businesses. The Catholic Church has announced plans to mobilize interested women to train them in the cultivation of mushroom for commercial production. Another community-based organization is ASTAR Fun club, which supports its members welfare needs, especially when a member is bereaved.

Control site - New Techiman. Information on this community of 2000 was obtained with 10

key informants (4 woman and 6 men) made up of the chief and his spokesperson, the queen mother's daughter, sub-chiefs and the secretary to the Moslems in the community This community lies about 20 km down the Techiman-Kumasi highway. It is the control community for Fiaso and is also a farming community presided over by a chief.

a. Infrastructure. The community has 2 functional pipe-borne water taps. The tap water is sold at 1-2 cents per bucket and is used mainly for drinking. There is a nearby stream that is mostly used for washing purposes. There is no electricity although the community has been wired but requires a power transformer. Kerosene lanterns and torch lights are used for light while car batteries are used for television. There are personal and public toilet facilities in the community. There are 8 of the ventilated improved pits for the public (4 for men and 4 for women). There are few personal ones but majority of the people use the public toilets. The Techiman-Kumasi highway passes through the community.

There is no health facility. People usually go to Tanoso (about 1.5miles), where there is a community health centre, and sometimes to Techiman, to access hospital facilities. Community health nurses (from Ghana Health Services) periodically come to the community to weigh and assess the growth of the children, provide child nutrition education as well as conduct immunizations. The community has also been part of the Vitamin A supplementation trials for reproductive women and under age 5 children.

The community has a nursery school, kindergarten, primary and junior secondary school, which are government owned. There is a privately owned international school with nursery and primary facilities in Tanoso. People who have animals usually report problems to the MOFA office in Techiman before the veterinary officer visits the community.

There is a main market area in the community where they sell foodstuffs such as tomato, maize, plantain and cassava. There are about 9 kiosks mainly for the sale of provisions. The nearest major markets are Akomadan and Techiman. Transport fare to Akumadan is 19 cents (taxi) and 11 cents (minibus). Transport for Techiman is 44 cents (taxi) and 33 cents (minibus).

b. Food Security. The main staples consumed are cassava, plantain, cocoyam, corn, and yam. All the staple food crops are grown in the community. The most difficult months for obtaining major staple crops are March– May and June-August. The primary ASF consumed in the community are fish, bush meat, beef, and chicken. Whereas fish is always available in the community, bush meat is common from December – February, when there are bush fires. Beef and chicken are mostly used during festivities and also during harvest where people have money.

There are no communal silos or storage banks for grain, other food crops, or ASF. Individuals store their own foods within their compounds. There are a few individual food processing activities in the community. These include palm nut oil extraction and fish smoking.

No community-wide food prohibitions for pregnant or lactating women or children.

Table 15. Control site, New Techiman. Associations or formed groups.

Name of group	Purpose of group
Queen mother's association	Using drama to help prevent HIV / AIDS
First Aid Group	Training on first aid methods
Fire Service Volunteers	Training on fire prevention methods
Fish mongers association	Trading in Fish

c. Associations. The Queen Mother's Association is a women's group. The other groups are mixed.

Upper East Region. The two intervention communities are Gia (Kassena Nankana District) and Wuru (Kassena Nankana District) and the two control communities are Biu-Sensa (Kassena Nankana District, match for Gia) and Bonia (Kassena Nankana District, match for Wuru). Data collection for community profile: August 24 to September 5, 2005. Some of the preliminary analyses of the baseline characteristics are shown in Tables 17-18. Additional analyses are continuing. The intervention site had high diet diversity score than the control site in the rural area; weight-for-

height and weight-for-age tended to be higher also.

Intervention site – Gia. Information was obtained through observations and key-informant interviews with 4 key informants (2 women and 2 men) made up of the chief of the Gia community, his wife, the wife of the former assemblyman, and a community member and other opinion leaders in the community. This is a rural community setting basically engaged in fish and crop farming. There are dams and canals which are used for crop farming irrigation and fishing during the raining season. The community is presided over by a chief.

a. Infrastructure. There are about 8 hand-dug wells, which are constructed and owned by individuals or groups of individuals. These are used for all domestic purposes including drinking and washing in the dry season. However, during rainy season, water can be fetched from the dams and canals for bathing, washing and irrigation purposes. There is no electricity. Kerosene lanterns, flashlights, dry cells and car batteries are commonly used for lighting and energy needs. There are no toilet facilities (private or public). The major road leading into the community is not graveled; it and roads within the community are very difficult to access during rainy season, especially during August - September. People in the community use bicycles or walk to vehicles. It is a short distance (2 miles) to Navrongo.

There is no established health facility; however, there is one resident community nurse stationed to handle first aid casualties and four surveillance health volunteers, working under the supervision of the Ghana Health Service (GHS). Others include the privately owned traditional healers (20) and suite sayers (4). Community members sometimes use health facilities in neighboring towns like the Navrongo hospital, Bolga hospital or the clinic at Weiga. Bolga and Weiga are about 18 miles and 21 miles respectively, away from Gia. There is the Ghana Education Service - WFP supported program in the primary school to feed children with sorghum and wheat. The government, through the Navrongo Health Research Institute, occasionally organizes outreach programs on disease control and family planning.

Veterinary personnel with the MOFA office in Navrongo visit the community periodically to treat sick animals in the community. Currently a private teacher in a community nearby also comes around, 3-4 times every month to treat people's animals at a cost of about 7000 cedis per head per vaccination/ de-worming. Unlike the MOFA personnel who would charge 5000 cedis as a token fee.

There is the Tono School comprising a day care, primary and junior secondary school, which is about a kilometer away from the community. The school is owned by the Tono Irrigation Centre and some of the children from this community attend school there. Some of the children also attend primary and JSS in other nearby communities known as Korania and Awe which are about 2-3 kilometer away.

There is small community market and about 4 table-top shops, which are opened for sale every day in the community. Apart from these, consumers and traders alike, travel to Navrongo or Paga to trade and do purchases, during their respective market days. Whereas Navrongo is about 2 miles, Paga is about 5 miles. Travelers usually walk, use the bike, or the donkey. Vehicles are used sparingly. It takes about 45 minutes to walk a distance of 1 mile, while riding bicycle would take about 10 minutes. The Tono Irrigation Dam site is open for the sale of catch fresh fish (ASF).

Table 16. Intervention site, Gia. Associations or formed groups.

Name of group	Purpose of group
Fishmongers group	To secure credit for trading
Fishermen group	To secure funds for fishing activities
Forestation group	To seek for assistance for forestation activities
Women's welfare group	Welfare issues

b. Food Security. The main staples consumed are millet, corn, rice, groundnuts, and cowpea, all of which are produced in the community at least during the rain season. Difficult months for obtaining the main staples for consumption are March to July. The primary ASF consumed is fish, followed by poultry meat, livestock and lastly eggs. Peak fishing season is from May to August. However fish is consumed year round.

There are no communal silos or storage banks for grain, other food crops or ASF. Individuals store their own foods within their compounds. Food processing activities in the community are carried out by individuals and these include the extraction of shea-butter, preparation of malt for pito brewing, parboiling, and milling of rice. Smoking of fish is done on small scale basis.

There are no community-wide food prohibitions for pregnant or lactating women or children.

Intervention site – Wuru. Information about this community of about 400 was obtained through observations and key-informant interviews with 7 key informants (2 women and 5 men) made up of the landlord, village group animator and other community leaders. The Wuru community is about 1 km from Navrongo and is therefore selected as a semi-urban intervention community. It is also presided over by a chief. The main occupation in the community is farming.

a. Infrastructure. There are 2 bore holes, 3 improved hand-dug wells and a near-by stream, which are usually used for drinking and cooking. There are many individually constructed local hand-dug wells plus the stream, which serve as water sources for other domestic purposes including bathing and washing. However, during rainy season, water can be fetched from the dams and canals for bathing and washing, and also irrigation purposes.

There is no electricity. Kerosene lanterns, flashlights and dry cells are commonly used for lighting needs. Few people use car batteries as energy sources for tape recorders and televisions (black/ white). There are no toilet facilities (private or public).

The major road leading into the community is good but roads within the community are poor and very difficult to access during rainy season. People in the community prefer using the bicycle or walking to vehicles.

There is no well established health facility within the community; however, there is one resident community nurse stationed to handle first aid casualties, three health surveillance volunteers and four traditional birth attendants, working under the supervision of the Ghana Health Service (GHS). Others include the privately owned traditional healers (25) and suite sayers (4) in the community. Community members sometimes use health facilities in neighboring towns like the Navrongo hospital, Bolga hospital or the clinic at Weiga. Bolga and Weiga are about 16 miles and 20 miles respectively, away from Wuru. The Ghana Health Service, through the community health delivery programs periodically come to the community to weigh children and do immunizations. Community health nurses also conduct home visits to encourage mothers to feed their children, including talks on malaria control, and HIV/AIDS and family planning education.

The community does not have a school but there is the Tono School comprising a day care, primary and junior secondary school, which is about 1.5 km away. Some of the children also attend primary and JSS in other nearby communities such as Korania and Navrongo which are within a kilometer stretch.

There is no community market but there are about 15 table-top shops, which are opened for the sale of provisions every day in the community. Consumers and traders alike, travel to Navrongo, Paga or Bolga to trade and do purchases, during their respective market days. Whereas Navrongo is about a kilometer from the community, Paga is about 6 miles. Travelers usually walk, use the bike, or the donkey. Vehicles are used especially when they have to travel to sell or shop at long distances. Key informants estimated that it takes about 45 minutes to walk a distance of 1 mile, while riding bicycle would take about 10 minutes.

b. Food Security. The main staples consumed are millet, sorghum, corn, rice, assorted vegetables and gari. With the exception of gari (cassava), all the commodities are produced in the community at least during the rainy season. Difficult months for obtaining the main staples for consumption are at two different periods: March to June and December to August. The primary ASF consumed in the community is fish, followed by poultry meat, livestock (in the order of goat, pork, sheep and cattle) and lastly, eggs. Peak fishing season is from June to October. However fish is consumed year round.

There are no communal silos or storage banks for grain, other food crops or ASF. Individuals store their own foods within their compounds. Food

Table 17. 24-hour household diet diversity score in intervention and control communities for the Upper East Region of Ghana (northern savannah)

Foods Consumed	Rural			Semi-urban[1]		
	Intervention N=76	Control N=60	P-value[3]	Intervention N=70	Control N=73	P-value
Cereal based	98.7 (76)[2]	96.6 (57)	0.4106	98.6 (69)	98.7 (74)	1.0000
Roots and tubers	6.5 (5)	10 (6)	0.4537	10 (7)	10.7 (8)	0.8952
Vegetables	92.2 (71)	85.0 (51)	0.1801	95.7 (67)	90.7 (68)	0.3293
Fruits	6.5 (5)	3.3 (2)	0.4670	1.4 (1)	0 (0)	0.4828
Pulses and nuts	44.2 (34)	38.3 (23)	0.4927	47.1 (33)	45.3 (34)	0.8271
Livestock, bush meats and poultry	9.1 (7)	10.0 (6)	0.8570	17.1 (12)	10.7 (8)	0.2584
Eggs	19.5 (15)	6.7 (4)	0.0313	14.3 (10)	22.7 (17)	0.1952
Fish and shellfish	90.9 (70)	98.3 (59)	0.0791	91.4 (64)	98.7 (74)	0.0564
Milk and milk productions	3.9 (3)	0 (0)	0.2561	4.3 (3)	2.7 (2)	0.6727
Foods made with oils	54.5 (42)	51.7 (31)	0.7376	47.1 (33)	65.3 (49)	0.0272
Sugar or honey	31.2 (24)	20.0 (12)	0.1406	21.4 (15)	26.7 (20)	0.4614
Condiments and beverages	10.4 (8)	0 (0)	0.0094	4.3 (3)	5.3 (4)	1.0000
Diet diversity score[4]	4.64 ± 0.16[5]	4.16 ± 0.13	0.0337	4.53 ± 0.15	4.8 ± 0.15	0.2051

[1] Semi-urban sites were closer to major urban centers, had easier access to major roads, and had more community infrastructure.
[2] % (n) 3 Analyses used Student's t-test for continuous variables and Chi-square or Fischer's exact test for categorical variables.
[4]Maximum summed diet diversity score=12 [5] Mean ± SEM

Table 18. Characteristics of reference children in intervention and control communities for the Upper East Region of Ghana (northern savannah)

	Rural			Semi-urban[1]		
	Intervention N=76	Control N=60	P-value[2]	Intervention N=70	Control N=73	P-value
Age (mo)	41.3 ± 1.20[3]	42.2 ± 1.51	0.6461	43.08 ± 1.28	42.7 ± 1.23	0.8488
≥24-36	35.5 (27)[4]	35.0 (21)	0.7320	31.4 (22)	29.6 (21)	0.3533
>36-48	36.8 (28)	31.7 (19)		28.6 (20)	39.4 (28)	
>48-60	27.6 (21)	33.3 (20)		40.0 (28)	31.0 (22)	
Sex						
Male	49.3 (38)	56.7 (34)	0.3949	50.0 (35)	49.3 (37)	0.9361
Female	50.7 (39)	43.3 (26)		50.0 (35)	50.7 (38)	
Anthropometry[5]						
WHZ	-0.53 ± 0.09	-0.77 ± 0.10	0.0626	-0.63 ± 0.09	-0.65 ± 0.09	0.7944
>-2 Z-scores	98.7 (73)	93.3 (56)	0.1727	95.9 (67)	95.7 (70)	1.0000
≤-2 Z-scores	1.4 (1)	6.7 (4)		4.3 (3)	4.1 (3)	
WAZ	-1.33 ± 0.09	-1.57 ± 0.13	0.1470	-1.41 ± 0.11	-1.38 ± 0.10	0.8365
>-2 Z-scores	81.3 (61)	66.7 (40)	0.0511	70.0 (49)	80.3 (57)	0.1576
≤-2 Z-scores	18.7 (14)	33.3 (20)		30.0 (21)	19.7 (14)	
HAZ	-1.45 ± 0.10	-1.55 ± 0.16	0.6188	-1.45 ± 0.12	-1.35 ± 0.11	0.5660
>-2 Z-scores	66.2 (49)	63.3 (38)	0.7280	57.7 (53)	78.6 (55)	0.6873
≤-2 Z-scores	33.8 (25)	36.7 (22)		24.3 (17)	21.4 (15)	

[1]Semi-urban sites were closer to major urban centers, had easier access to major roads, and had more community infrastructure.
[2]Analyses used Chi-square or Fischer's exact test for intervention-control comparisons of use of individual ASF.
[3]Mean ± SD
[4] % (n) [5] Flagged data (> 4 SD or missing age) were not included.

processing activities in the community are carried out by individuals and these include the extraction of shea-butter, preparation of malt for pito brewing, shelling of groundnuts, parboiling, and milling of rice.

No community-wide food taboos for pregnant or lactating women or children. Natives of Paga are not supposed to eat crocodile meat.

The veterinary personnel with the MOFA office in Navrongo do visit the community, though irregularly to treat sick animals in the community at no cost.

Table 19. Intervention site, Wuru. Associations or formed groups.

Name of group	Purpose of group
Women's welfare group	Source for credit to help women start and manage income generating activities
Youth group	Welfare / benevolence for members

Control site – Bonia-Bagensik. Information for this community of 800 (with 215 housing units) obtained through observations and key-informant interviews with 6 key informants (3 women and 3 men) made up of chief, a couple of health volunteers and other community members engaged in farming who were selected by the chief. The community is about 2 km from Navrongo. It is presided over by a chief. The main occupation in the community is farming as well as fishing.

a. Infrastructure. There are 3 bore boles plus 3 others yet to be installed. These bore holes are distributed throughout the community and are used for all domestic purposes, including drinking and washing. The irrigation canals are used for farming and fishing activities. There is no electricity. Kerosene lanterns, candles, flashlights and dry cells are commonly used for lighting needs. A few people use car batteries as energy sources for tape recorders. There is one solar panel in use by the community health nurse in charge of weighing and other community immunizations. There are no toilet facilities (private or public).

The major road stretching from Navrongo to the community is tarred and very good. However, the roads within the community are poor and very difficult to access during rainy season. People in the community usually prefer using the donkey, bicycle or walking to vehicles.

There is no well established health facility within the community. However, key informants explained that there are four health surveillance volunteers and two traditional birth attendants, working under the supervision of the Ghana Health Service (GHS). In addition, there are about 20 traditional healers. Community members sometimes use government owned health facilities in neighboring communities like the Navrongo hospital, Bolga hospital, Sandema hospital or the clinic at Weiga. Bolga and Weiga are about 17 miles and 19 miles respectively, away from Bonia. The Ghana Health Service, through the community health delivery programs periodically come to monitor the growth of children, give vaccinations on tetanus and also carry out control programs on malaria and elephantiasis.

The community has a day nursery and a primary school; just about 0.5 km away. There is also the Tono Day care, Primary and JSS (1 km away) and the Korania Primary and JSS (2 km) where some of the children attend school.

Community members who have problems with their animals would have to make a request to the veterinary personnel at the MOFA office in Navrongo. The officer is reported to be staying in a nearby community so people also go to his residence to book appointments. Visits are therefore scheduled regularly to treat animals at the following rates – 56 cents for Newcastle disease against fowls; $2.20 for deworming; and $5.56 for full treatment of cow diseases.

There is no community market but there are about 15 – 20 table-top shops, which are opened for the sale of provisions every day in the community. Apart from these, consumers and traders alike, travel to Navrongo, Paga or Bolga, Sandema and Chiana to trade and do purchases, during their respective market days. Transport fares from the community to the above markets are as follows: Navrongo 22-33 cents; Sandema 56 cents, and Chiana 56 cents. Vehicles are used especially when people have to travel to sell or buy at long distances.

b. Food Security. The main staples consumed are millet, corn, sorghum, groundnuts, rice and assorted

vegetables. All the commodities are produced in the community at least during the rainy season. Difficult months for obtaining the main staples for consumption are March through to September. The primary ASF consumed in the community is fish, followed by poultry meat, livestock (in the order of pork, goat, sheep and cattle) and lastly, eggs. Peak fishing season is from August to December. However fish is consumed year round.

There are no communal silos or storage banks for grain, other food crops, or ASF. Individuals store their own foods within their compounds. Food processing activities in the community are carried out by individuals and these include the extraction of shea-butter, preparation of malt for pito brewing and shelling of groundnuts.

There are no community-wide food taboos for pregnant or lactating women or children. Ancestral beliefs forbid the natives of Bonia to consume the meat of crocodile, monitor lizard, and royal python.

Control site – Biu-Sensa. The information on this community of about 180 households was obtained through observations and key-informant interviews with 4 key informants (2 woman and 2 men) made up of the chief, a farmer and two other women who are involved in trading and farming. The community is about 9 miles from Navrongo and is presided over by a chief. The main occupation in the community is farming.

Table 20. Control site, Bonia-Bagensik. Associations or formed groups.

Name of group	Purpose of group
Farmer group	To access credit for income generating activities
Young women's group	To source for credit for the group and also seek the welfare of members
Male farmer's group	To access credit for income generating activities as well as seek for the welfare of farmers
Male Welfare group	To source for credit for the group and also seek the welfare of members

a. Infrastructure. There is only 1 bore bole in the community. However, there are 5 hand dug wells distributed within the community for all domestic purposes, including drinking and washing. The irrigation canals are used for farming and fishing activities but are sometimes used for other domestic purposes including cooking and washing. There is no electricity. Kerosene lanterns, candles, flashlights and dry cells are commonly used for lighting needs. A few people use solar panels and car batteries as light and energy sources. There are no toilet facilities (private or public) in the community.

The major road leading into the community is good, though not tarred. However, the roads within the community itself are poor and very difficult to access during rainy season.

Walking, donkeys, bicycle/ motor bikes and vehicles, are the main means of transport for the people in the community.

There is a community health centre in Biu-Sensa. The community also has 8 health surveillance volunteers and 6 traditional birth attendants, working under the supervision of the Ghana Health Service (GHS). In addition, there are 16 traditional healers and 3 suite sayers, which are managed by private individuals. Apart from these, community members sometimes use government owned health facilities in neighboring communities like the Navrongo hospital, Bolga hospital, Sandema hospital Chichulga clinic or the clinic at Weiga. Chichulga is about 3 miles from the community. The Ghana Health Service, through the Community health delivery programs periodically come to immunize and monitor the growth of children through weighing, talk to them about family planning and HIV/AIDS education programs as well as sensitize the people on hygiene in the homes, especially washing of hands.

The community has a day nursery, two primary schools and a junior secondary school, which are all owned by the government. Some parents also take their children to school (JSS/SSS) at Navrongo and Bolga.

A veterinary officer has been assigned to the community but the officer does not visit the community. People in the community use their own indigenous knowledge to treat animals when they are sick.

There is a small market place at the centre of

the community. Few individuals also sell provisions on table tops in their homes on daily basis. Apart from these, consumers and traders alike, travel to Navrongo, Chichulga and Korogo to trade and do purchases, during their respective market days. Korogo is 4 miles from Biu-Sensa. Transport fare to Navrongo ranges between 39-56 cents. For the other two communities, travelers would either walk or use bicycle. Key informants estimated that a mile's walk would take about 20 minutes. It was reported that it becomes very difficult to travel to Chiculga when it rains heavily because there is a river across the road without a bridge.

b. Food Security. The main staples consumed are millet, corn, sorghum, rice, cowpea and groundnuts. Others include yam and gari from cassava but these are not produced from the locality. Difficult months for obtaining the main staples for consumption are March through to September. The primary ASF consumed in the community is fish, followed by poultry meat, livestock (in the order of pork, sheep, goat and cattle) and lastly, eggs. Peak fishing season is from September and October. However fish is consumed year round.

Table 21. Control site, Biu-Sensa. Associations or formed groups.

Name of group	Purpose of group
Women's group	Women's empowerment through trade (used to work with 31st December Movement)
Poscom's mixed group	To access credit for income generating activities
ICOUR's group	Environmental protection through reforestation

There is a three compartment store-house in the community where commodities such as rice and gari are stored. This was built by a group of traders in the community with contributions of member traders, with the community chief as their leader. Member users also contribute variable proportions of stored commodities to be sold and the money used to hire for security and pay for maintenance. The group pays $16.67 for maintenance/ security every season of about 3 months. However, individuals store their own foods within their compounds. Food processing activities in the community are carried out by individuals and these include the extraction of shea-butter, preparation of malt for pito brewing, parboiling of rice, milling of corn, shelling of groundnuts and burning of charcoal.

No community-wide food taboos for pregnant or lactating women or children.

Activity Four: Training of Graduate Students

Problem Statement and Approach. The development of young researchers interested in multi-disciplinary research in the area of nutrition and agriculture was a key component of this project.

Planned activities. The graduate training was planned at two levels: 1) a series of activities that would develop a Ghana-Uganda intellectual exchange through graduate training of a Ugandan student, faculty visits, and development of preliminary research activities in Uganda. The support of the Iowa State University Sustainable Rural Livelihoods program will assist in achieving regionalism of our research and program development process. Our local collaborators in both Ghana and Uganda will assist in disseminating the results of our project. Each country will be able to influence countries in their sub-region.

Importance. Today, students' graduate training is specialized with little cross over between agriculture and nutrition. Given the complex problems of child health today, graduates need to have knowledge of and be able to work with methodologies and professionals from multiple disciplines.

Plans to accomplish activity. The inclusion of Uganda in this project is a reflection of the unique situation of the ISU team that has established what we feel represents a long-term relationship in both Ghana and Uganda. Drs. Marquis and Butler are involved in a 15+y Sustainable Rural Livelihoods program [SRL] that focuses on the development of sustainable livelihood approaches to improve health, nutrition, and agriculture of rural populations with a priority on young children. A major limitation in Uganda is the lack of trained nutrition professionals which has contributed to poor integration of nutrition, health, and agriculture. In contrast, Ghana has a well-respected graduate program in

nutrition. The inclusion of Uganda is seen as an opportunity to establish a foundation for student and research exchange between African universities and so enhance professional development within the continent.

Progress.

Planned outputs and completion of tasks

1. Set criteria for selection of Ugandan student: Criteria were agreed upon by the ENAM team and included: 1) meet university entrance requirements, 2) interest in agriculture extension, human nutrition, or animal science, 3) interest in community-based research, and 4) willingness to conduct master's thesis research in Uganda on animal source foods.

2. Selection of Ugandan student: Makerere University collaborators (Dr. Mateete Bekunda, Dean of the Faculty of Agriculture; Faculty of Agriculture department heads) were asked to advertise the training opportunity and nominate two candidates for the master's program. The two applications were sent to the ENAM project for review by the Ghana and US ENAM teams. They included:

Henry Kaweesa: (BS in agriculture-2nd class honors; diploma in Education)

Samuel Oluka (BS in Food Science-and Technology with some coursework in Nutrition-1st class honors).

Mr. Oluka was selected based on the excellence of his academic performance, coursework, background, and interests that were more suited to the focus area of the project, and a belief that he would be a more likely candidate to contribute to nutrition extension work in Uganda.

3. Initiation of MPhil training: Mr. Oluka arrived in Ghana and has begun the academic coursework for Human Nutrition.

Activity Five: Curriculum (Nutrition Extension) Development

Problem Statement and Approach. To date there is no systematic training of professionals in the area of nutrition extension nor is there a merging of experiences across nutrition and agriculture that would strengthen the existing community outreach activities.

Planned activities. The project will work to develop undergraduate coursework as well as continuing education training for field staff.

Importance. The development of a multidisciplinary curriculum for a nutrition extension program for University of Ghana will expand opportunities within the sub-Saharan African region for training in applied community-based agriculture and public health/nutrition. The program will enhance research and outreach capabilities to address ASF and other agriculture, nutrition, and public issues in the region.

Plans to accomplish activity. The program manager, Dr. Esi Colecraft will work with ISU and University of Ghana faculty, a consultant (Dr. Perez-Escamilla of U of Connecticut), as well as ministry staff to develop a curriculum on nutrition extension for the undergraduates as well as a program of continuing education for in-field staff.

Progress.

Planned outputs and completion of tasks

1. Develop collaborations with Dr. Rafael Perez-Escamilla (University of Connecticut, Storrs): Dr. Perez-Escamilla visited the ENAM project in Ghana on Oct 31-November 6, 2005. During the visit, he met with the ENAM team to discuss models for nutrition extension and provided a seminar on the Connecticut experience. He met with Dr. Colecraft who will be developing the curriculum.

2. Development of curriculum and materials for undergraduate program in Nutrition Extension: Dr. Colecraft continues to collect materials for a course which has been discussed with the department head of nutrition to be offered in 2006.

Gender

This section addresses the following two questions asked by USAID:

1) How will gender relations affect the achievement of sustainable results?

2) How will proposed results affect the relative status of men and women?

Research. The primary goal of the project is to improve the nutritional status of young children

in sub-Saharan Africa. In Ghana, agriculture production, food preparation and child care, including child feeding, are gender defined. Typically, men provide the main component of the meal (e.g., corn, millet, sorghum, cassava) and women are responsible for the ingredients for the sauces/stews to accompany the starch (e.g., tomatoes, onions, okra, ASF). Women own small animals; however, their ability to commercialize animal products or slaughter animals may be limited by the need for approval of male adult family members. Women are the primary child caregivers. However, actual practices may differ from the stereotypes and these issues will have to be evaluated in each region/community to determine how specific gender issues will limit or enhance the possible intervention approaches and the long-term success of the program. This project, with a focus on child well-being, will rely heavily on women. The ability of those women to respond and participate will depend in part on their own cultural environment.

The project goal will be accomplished through targeted income-generation and skill building activities to caregivers of children 2-5 y of age and their households as well as interactions with the entire community to sensitize it to the problems, consequences, and solutions for child malnutrition. Participants of a recent planning workshop emphatically encouraged the ENAM project to incorporate sensitization activities for the entire community to improve the acceptability of the targeted activities and increase the likelihood that there would be social support for the caregivers to engage and sustain the new IGA and child care practices. The interventions will work to improve knowledge and skills that will enhance access to ASF through income-generation activities and processing and storage technologies for ASF. By strengthening caregivers' economic capabilities and removing their knowledge and skill barriers, the project will empower caregivers to adequately address the nutritional needs of themselves as well as their children.

The project will not alter the division of labor in the household but will work to increase training opportunities for women needed for specific IGA's, increase the level and success of women's participation in economic endeavors, increase their control of their own ASF-related resources, and improve their access to health, agriculture, and other information relevant for their child's health. Two of the research objectives directly address this issue by examining empowerment of women in relationship to food access and child feeding.

Does the implementation of a program in income generating activities enhance caregivers' self-efficacy (as a proxy for empowerment) with respect to year round household availability and utilization of ASF for children?

Do project educational programs associated with the IGA improve caregiver and households' knowledge, attitudes and practices relative to household ASF allocation and child feeding practices?

Training. The project provides training through regional workshops for extension staff and coursework and research opportunities for students at the university. The training is for both men and women; special emphasis will be placed on encouraging women who are training in agriculture-related areas in order to increase the number of women in the field. One of the two Ghanaian master's students who are being supported by the ENAM project is female. The program manager position provides an entry into the University of Ghana for Dr. Esi Colecraft, who has been given a part-time lecturer position in the Department of Nutrition and Food Science. All three of the regional field coordinators are female. The importance of role models for young women is significant. In addition, we are working to identify women in the communities who have been successful in IGA's to serve as mentors for the study groups. Finally, the development of a nutrition extension curriculum is expected to help many female students in the future by opening additional employment opportunities for them.

The series of research questions that have been described above will be documented through data collection at baseline and at appropriate time intervals (depending on the variables of interest). All data collected at the individual level (for example, to document dietary intakes, anthropometric measurements, knowledge/attitudes/beliefs) will

account for gender and age as well as other demographic characteristics that will be of interest in particular analyses. These other characteristics include work activities, educational experience, marital status, parity for adult women, among others. Similar characteristics will be collected for group activities --for example, we will document the age, sex, and other relevant characteristics of those attending training sessions, community-based or formal school educational activities, and other group activities. Individuals may play many different roles within a household or a community, and these roles may change over time or season. Qualitative data will be collected also on participants' perceptions of their roles and how they view any changes with intervention participation.

Policy

The ENAM project continued to invite high level ministry officials to our meetings/workshops and to disseminate our findings as we progress. In addition, we have visited USAID twice this past year to introduce and then keep them informed about the project's progress. The first year workshop (June 2005) provided the opportunity to officially launch the project and allowed the ENAM staff to share the project's initial results on the "best practices" for income-generating activities. We had a representative from the Ministry of Women and Children's Affairs give the keynote address at the June workshop on income generation activities to enhance child nutrition. The representative then decided to participate for both days of the workshop and showed keen interest in the discussions. A copy of the workshop report was submitted to the agriculture and health ministries. The team continued to work closely with district-level personnel of the Ministry of Food and Agriculture (MOFA) whose reports from the field have a bearing on policy decisions. MOFA has made a commitment to the project as demonstrated through the provision of study office space. We have been asked by the Women in Agriculture Development office to consider working on nutrition curriculum that could be used for continuing education for their field staff. To ensure "buy in" from policy makers, consultations have been initiated by the policy makers at the Nutrition, Reproductive and Child Health Department of the Ministry of Health, Women in Agricultural Development Department of the Ministry of Food and Agriculture, ADRA, Provost of the College of Agriculture – University of Ghana, to serve on the National Level Project Advisory Council. ADRA has indicated their willingness to collaborate with the ENAM project activities in their upcoming program years.

Outreach

The project is focused on working with community-based women's groups in three regions of Ghana: Central, Brong-Ahafo, and Upper East. These represent the three main agro-ecological zones of Ghana. The project activities to date have included focus group discussions and interviewer-administered questionnaires with caregivers in all of the households with children 2-5 y of age, in 12 low-income communities in these three regions. If it is necessary in some communities, participation will be prioritized by children's nutritional status to assure that the families with the poorest conditions are reached.

As one activity of this project, Dr. Colecraft will work on the development of a nutrition extension curriculum for an academic program (a general extension master's program that would span nutrition and agriculture) and a certificate/diploma program that would serve the needs of extension agents that need continuing education. These would be offered through the University of Ghana and the certificate/diploma program has been informally requested by the Women in Agriculture Development Office of the Ministry of Food and Agriculture and the Ghana Health Services. Dr. Colecraft has been appointed as a part-time Lecturer in the Department of Nutrition and Food Science at the University of Ghana for the academic year 2005/06 to facilitate this goal.

Developmental Impact

Environmental impact and relevance The project activities will contribute to improved use of ASF, due to improved harvesting / husbandry,

handling, processing and marketing of ASF in the study communities and beyond, imply that the water bodies, forest and the grasslands from which the ASF are directly or indirectly produced or obtained will be more efficiently utilized, thereby result in positive environmental impact.

Agricultural sustainability. The activities targeted by the project encourage the production, distribution and utilization of the livestock. The production generates by-products which can be used for composting / manure for soil fertility management. Improving soil management will improve production of all agricultural products.

Contributions to U.S. agriculture. This project has no direct effect on US agriculture. However, it has provided international training for an Iowa State University undergraduate agriculture student, Abbey Avery, who is majoring in Animal Science and is open to further training opportunities for other students. Knowledge gained through her summer 2005 experience with the ENAM project will benefit her future professional development and contribution.

Contributions to host country. An aim of the ENAM project is to improve the nutritional well-being of vulnerable children in sub-Saharan Africa and to build a healthy and productive population base for future development. Over half of childhood mortality can be attributed to malnutrition. Improved diets of the young population will contribute to the future society.

The development of an integrated curriculum that addresses agriculture, nutrition, economic, social, and community issues will be on-going throughout this project year. Over time, the curriculum developed at the U of Ghana may influence Makerere University's curricula. This curriculum will facilitate continued problem assessment and identification of promising interventions, thereby adapting university research to the real needs of vulnerable groups. The highly interactive nature of the project will foster continued dialogue and information sharing with communities and organizations. This will generate recommendations and policy initiatives leading to more integrated regional interventions in health and agriculture. The training of Ghanaian and Ugandan graduate students will have a long-term effect through their influence as young professionals.

Linkages and networking. The project has planned activities in Ghana, Uganda, and the US to integrate disciplines and develop local and regional networks to reduce poverty and promote children's well-being. The resource-poor, sub-Saharan Africa region will benefit through the sharing of resources and expertise in mutually beneficial ways. Uganda has few trained nutritionists and a graduate program that is just starting this year. The country will benefit from the training that the well-established nutrition program at University of Ghana can provide for one of their talented Makerere University students. Faculty and students at Makerere University as well as staff from non-governmental organizations will benefit from the short-course training that will be provided by Dr. Sakyi-Dawson on community development research methods. Ghana will benefit from the enrichment of their graduate student population with a talented Ugandan and the interactions that they will have with Dr. Muyanja, a food scientist. The Ghana staff are working on furthering the collaborations with district-level government agencies to combine nutrition (and other) education resources in the area.

Collaboration with international research centers (IARCS) and other CRSPs. The ENAM project is not presently collaborating with the IARCS. We have had some collaboration with one scientist from the Bean and Cowpea CRSP (Dr. Esther Sakyi-Dawson, University of Ghana) who has completed a small preliminary study to look at the feasibility of drying meat for children's diets.

Other Contributions

Support for free markets and broad-based economic growth. The development of market linkages for animal source food products will be based mainly on free-market principles, with the members of the local communities being provided with technical assistance and being empowered to access appropriate services from governmental and private sources.

Contributions to and compliance with mission objectives. The overall objective of the mission is to promote "equitable economic growth

and accelerated poverty reduction within a system of sound democratic governance". The mission has four main strategic objectives; our project contributes to the third objective of improved health status. Through collaborations of the project with staff from the district Ghana Health Services, we are promoting community-based service delivery and linking health to other development activities at district and community level. Although this project is not specifically targeted to people living with HIV/AIDS, it is targeted to the most needy, some of whom will be infected with HIV.

Concern for individuals. Freedom of individuals to make informed choices for themselves underlines all project processes. Individuals will be invited to participate in group activities; participation is an individual choice and they will be informed of their right to disengage from any or all activities at any time. The data collection has been reviewed and approved by the Institutional Review Board at Iowa State University and the project assures confidentiality of the data.

Support for democracy. All technical assistance to the project will be provided to community members through participatory group activities to enhance social learning and mutual support. The process of group dynamics among community members encourages active participation in decision-making and may translate in increased empowerment of the community as individuals and as a whole.

Humanitarian assistance. Access to adequate, safe food is a human right. This project is focused on increasing the use of nutrient-rich animal source foods in the diets of young children to improve their health, growth, and cognitive development. The activities do not provide a direct transfer of goods but will increase households' ability to access a quality diet for their children.

Leveraged Funds and Linked Projects

A total estimated value for leveraged funds for the ENAM project during 2005 is $11,940. The sources of those funds were as follows:

USAID SANREM Mazur, 05/05-09/05, $1,500.

Wallace Chair for Sustainable Agriculture/ISU Foundation, travel for LM Butler, continuous $2,600.

Sustainable Rural Livelihoods Program/(ISU Foundation), travel for Marquis, continuous $3,000.

Program for Women in Science and Engineering, ISU, travel for Abbey Avery to work on ENAM project, Lonergan, July 2005 $ 1,665.

Office of Global Agriculture (SU), travel for Abbey Avery to work on ENAM project, Lonergan, July 2005 $1,500.

Animal and Nutrition Research Foundation, travel for Abbey Avery to work on ENAM project, Lonergan, July 2005 $ 771.

ISU Graduate College, Professional Advancement Grant, R Aryeetey (For EB 2005 poster presentation of ENAM results), April 2005 $354.

Center for Designing Food to Improve Nutrition (ISU), Travel Grant, R Aryeetey (For EB 2005 poster presentation of ENAM results), April 2005, $300.

NIH/NICHD , RIING (Research on Improving Infant Nutrition and Growth) training, Marquis, August 2-7, 2005 $100.

Ministry of Food and Agriculture Office space in Navrongo ($50/mo*3 mo) $150.

Training

Degree Training

Oluka, Samuel. Ugandan, M, U of Ghana, Nutrition, MS.

Avery, Abbey. USA, F, Iowa State University, Animal Science, BS.

Aryeetey, Richmond. Ghanaian, M, Iowa State University, Nutrition, PhD.

Addo, Adolphina. Ghanaian, F, Iowa State University, Nutrition, MS.

Agjei, Gladys. Ghanaian, F, U of Ghana, Nutrition, M Phil.

Christian, Aaron. Ghanaian, M, U of Ghana, Nutrition, M Phil

Non- Degree Training

Workshop on Income Generation Activities to Enhance Child Nutrition, June 2-3, 2005 in Legon, Ghana. Facilitators: Ghana ENAM team, Marquis, Butler, Jensen. To Launch ENAM project, share IGA results, develop consensus for ENAM activities. Attended by 42 participants (19 male and 23 female).

Data collection and anthropometric training, June 30-Jul 4, 2005 at the University of Ghana. Facilitated by Dr. Colecraft, Frederick Grant, and Richard Tweneboah-Koduah. Attended by 6 participants (2 male and 4 female).

Data collection and anthropometric training in Navrongo, August 8-9, 2005 at the University of Ghana. Facilitated by Alice Pwamang. Attended by 6 participants (2 male and 6 female).

Data collection and anthropometric training in Winneba, July 11-12, 2205 at the University of Ghana. Facilitated by Esi Colecraft and Richard Tweneboah-Koduah. Attended by 4 participants (2 male and 2 female).

Data collection and anthropometric training in Techiman, July 29-30, 2005 at the University of Ghana. Facilitated by Esi Colecraft and Richard Tweneboah-Koduah. Attended by 15 participants (11 male and 4 female).

YES Ghana Country Network (youth employment summit), April 20 , 2005 at the Ghana National Assoc. of Teachers Hall, Accra. To explore funding opportunities available for their development work and approaches for securing them. Attended by 1 participant (1 male).

Using EpiInfo software to analyze the DHS, August 9-12, 2005 at the University of Ghana. Facilitated by Richmond Aryeetey and Anna Lartey. Attended by 1 participant (1 male).

Collaborating Personnel

Ghana

Ahunu, Benjamin. University of Ghana, Animal Science/Statistics, PhD, Assoc. Professor

Canacoo, Emmanuel. University of Ghana, Veterinary Science, DVM, Senior Lecturer

Colecraft, Esi. Iowa State University, International Health/Nutrition, DrPH Prog. Coordinator

Lartey Anna. University of Ghana, Nutrition, PhD, Assoc. Professor

Sakyi-Dawson, Owuraku. University of Ghana, Agriculture Extension, PhD, Assoc. Professor

Uganda

Muyanja, Charles. Makerere University, Food Science, PhD, Senior Lecturer

United States

Butler, Lorna. Iowa State University, Sociology/ Anthropology, PhD, Professor

Jensen, Helen. Iowa State University, Economics, PhD, Professor

Lonergan, Elisabeth. Iowa State University, Animal Science, PhD, Assoc. Professor

Marquis, Grace. Iowa State University, Nutrition, PhD, Assoc. Professor

Reddy, Manju. Iowa State University, Nutrition, PhD, Assoc. Professor

Collaborating Institutions

Department of Food Science
and Human Nutrition
220 Mackay Hall
Iowa State University
Ames Iowa 50011 USA
Tel: 515-294-4437
Fax: 515-294-6193

Department of Nutrition and Food Science
University of Ghana,
Legon, Ghana
Tel: 233 (21) 514746
Fax: 233-21-500629

Faculty of Agriculture
Makerere University
PO Box 7062
Kampala, Uganda
Tel: 256-41-542277/531152

Publications

No papers are yet in press; one has been submitted to Ecology of Food and Nutrition and is under review.

Abstracts and Presentations

One abstract has been submitted to Experimental Biology 2006. "Nutritional status and diversity of animal source foods in the diets of 2- to 5-y-old Ghanaian children living in rural and peri-urban communities in a coastal district" Esi K Colecraft, Grace S Marquis, Anna A Lartey, Owuraku Sakyi-Dawson

Lead Principal Investigator

Grace S. Marquis, Professor, Department of Food Science and Human Nutrition, Iowa State University, Ames, IA 50011. Tel: (515) 294-4437; Fax: (515) 294-6193. Email: gmarquis@iastate.edu.

Sustainable Management of Rural Watersheds: Biophysical, Livestock and Human Interactions in the River Njoro Watershed

Narrative Summary

This report covers the third full research activity year of a multidisciplinary research effort focusing on biophysical and human-related factors governing watershed processes for the purpose of improving long-term sustainability of rural watersheds in Kenya and east Africa. Our research study site is a critical watershed in Kenya's Rift Valley that is undergoing considerable land cover change and population growth with associated negative impacts on water resources, human health, rural livelihoods, and the local economy. The River Njoro drains from the Mau escarpment through a series of pastoral, agrarian, and urban communities before passing into Lake Nakuru National Park and emptying into Lake Nakuru, an internationally recognized RAMSAR site. This year represents an effort to consolidate advances in research and capacity building and to better position the project for long-term success and functionality as a center of excellence in watershed research in Kenya. In this report a summary of advances made in both biophysical and stakeholder engagement efforts are reported, and institutional linkages and outreach activities are identified and presented. Monitoring and modeling activities are an ongoing and core component of this research, and these models are approaching maturation in application and are being migrated into the public realm through outreach activities

Faculty and scientists from three US academic institutions (University of Wyoming, University of California-Davis, Utah State University), two Kenya academic institutions (Moi University and Egerton University), and two Kenya governmental organizations (Kenya Fisheries Department and Kenya Wildlife Service) comprise the research team. This multidisciplinary team is subdivided into four components: watershed hydrology, ecology, stakeholder involvement, and socio-economics. A primary project goal is to develop a system whereby local engagement and applied research are coordinated to improve watershed health; as such, both high-quality academic research and stakeholder involvement are viewed as critical components to the long-term project success. The Njoro watershed is being developed as an experimental watershed where interactions among ecological and hydrological dynamics may be quantified in coordination with analyses regarding human metrics such as economic and health consequences resulting from land cover change. Numerous field studies have been initiated to provide basic information to a range of simulation models that will produce strong scientific understanding of the watershed system as well as provide key information to decision makers for policy guidance and effective land management.

Research

Activity 1: Evaluate project accomplishments and research capacity to date

Assessment of Livestock and Anthropogenic Influences: Pastoral Grazing in the Upper Watershed. Maasai pastoralists utilize grazing sites in the upper reaches of the watershed, areas that are highly susceptible to environmental degradation due to steep slopes and high rainfall. SUMAWA scientists have linked with local officials of the Ministry of Environment to investigate data on the number of cattle in this area. It was found that groups with several tribal affiliations have been utilizing the watershed including in the last five (5) years Maasai, Kalenjin and Ogiek. The spatial extent and intensity of grazing practices has yet to be fully assessed with respect to suitability and environmental risk caused by the periodic and large influx of migrant

Table 1. Livestock data in the Upper Reaches of River Njoro Watershed.

	2001		2003		2003		2004		2005	
Community	**Cattle**	**Sheep**	**Cattle**	**Sheep**	**Cattle**	**Sheep**	**Cattle**	**Sheep**	**Cattle**	**Sheep**
Maasai	3010	1350	3400	1500	1500	4150	4680	2130	7350	2130
Kalenjin	500	250	300	400	400	250	500	350	2200	400
Ogiek	486	400	350	350	350	500	500	700	1000	1500
Total	**3996**	**2000**	**4050**	**2250**	**4900**	**2300**	**5680**	**3180**	**10550**	**4030**

animals. A research framework has been established by SUMAWA that includes periodic site visits, interactions with local villages and community leaders, and sampling of water quality for sediment, pathogens and other indicators of degradation. Data relating to migrant animals from the neighboring regions is given in Table 1.

The table shows that the number of the cattle has risen by over 250% in the last five (5) years while the corresponding increase for sheep is about 200%. These increases portend potentially high instability to the environment and are theorized to be unsustainable with respect to ecological and hydrological function.

Household Monitoring and Economic Assessment. A baseline for project monitoring and evaluation of household-level socio-economic changes and impacts from project interventions in the River Njoro Watershed was established. Additionally, information and analyses to support socio-economic evaluations of other policy relevant conditions, activities, and issues in the watershed was developed. Understanding the socio-economic factors influencing land use changes, productivity of factors and change in economic activities requires the analysis of different economic structures from production, consumption to marketing, amongst others, of various produce and services within the watershed. In the past year we used a household survey instrument to identify and assess endogenous and exogenous relationships amongst these variables.

The target number of households for inclusion in the survey was determined using the formula

$$N = \frac{P * Q}{(SE)^2}$$

Where: N = sample size, P = proportion of the population containing the target attribute, Q = (1-P), SE = standard error of the proportion. In our case P = 0.5 since it is not possible for us to reliably estimate the proportion of the population containing the targeted attribute. The standard error is calculated using the specified confidence interval and confidence level. In this case our confidence is 5 percent and our confidence level is 95 percent. Following this approach we estimated the target sample size as N = 400 and a stratified random sample was drawn from the watershed population.

Training of local enumerators (e.g. not SUMAWA research scientists) was a key component to the successful implementation of the survey instrument. Six enumerators were recruited through key informants in the five River Njoro Watershed locations (Nessuit, Njoro, Ngata, Kaptembwa and Baruti). Because the watershed has multi-ethnicity, respondents were interviewed using a local translator conversant in local languages e.g. Kalenjin in the Nessuit location. The enumerators underwent a two-day training session conducted by the Socio-economic Component researchers. This was followed by a survey conducted in the watershed in the five targeted watershed community locations for a period of 30 days.

The River Njoro Watershed household survey targeted an area of approximately 275 km^2. The bulk of the survey itself was carried out at the end of the 2003/2004 research year but was not finalized until October / November of 2004. Due to gaps in the targeted population and errors in the surveys a final sample size of 364 households was taken. Preliminary results are presented here:

1) Agricultural Production. Survey data confirm that the dominant agricultural activities are crop and livestock production. Specifically, the most common crops grown in the watershed include maize,

beans, potatoes and wheat. Evidence also shows that maize is generally intercropped with beans. The common type of livestock comprises cattle, sheep and poultry, but donkeys and pigs are also kept on a much smaller scale. Most of the 23 agricultural activities are undertaken at household level, indicating that most watershed households practice subsistence farming and therefore do not generate sufficient income from crops. In regards to resource conservation within the watershed, most households indicated their awareness of soil conservation measures, among other things, but conceded that access to extension services was poor. According to most households, weak extension services lead to non-compliance with soil conservation measures resulting in detrimental effects. In some watershed locations, land tenure continues to be a sensitive issue that leads to households failing to invest in soil conservation measures, especially in Nessuit.

2) Landownership. Survey data indicate that the average landholding within the watershed is 3.4 acres per household. Nessuit has the highest average holding of 7.7 acres per household. Kaptembwo and Barut have the least holding at 1.3 acres. The proximity of the latter to Nakuru town and its relatively high population account for the average landholding. The average land under cultivation within the watershed is 2 acres while the average under pasture is 1.3 acres. Nessuit has both the highest amount of land under cultivation and pasture in the watershed as a whole. On the other hand, Kaptembwo has the least of both. In terms of the longevity of residents on their land within the watershed, the survey found that the average land occupancy was 15 years.

3) Education Status of Household Head. According to the survey findings, about 10% of the residents within the watershed have attained primary education of 1-4 years; 40% have attained primary education of between 5 and 8 years and 17% have no education at all. These findings further show that Nessuit location in the upper regions of the watershed (where rapid land cover change and population flux has been observed) has the highest level of illiteracy (28.5% of its sample population), with nearly no attainment of post-primary education. Kaptembwo location (nearer the outlet of the watershed and Nakuru town) has the highest literacy level, with over 50% of its respondents having acquired post-primary education.

4) Water and Sanitation. The survey reveals that about half of households within the watershed depend on River Njoro for their water needs, including livestock watering. In Nessuit, 100% of households are dependent on direct use of the river. This exerts pressure on water availability, especially during dry seasons and exposes families to high pathogen risks from polluted water consumption. In order to avert the water shortage and disease risk problems, some households use alternative sources such as roof catchments, boreholes and piped water. These other sources should be encouraged in the watershed mainly because of the declining levels and clarity of the river water. The declining water clarity is attributed to factors such as increasing population due to changes in land use patterns in the upper reaches of the watershed and increases in domestic and industrial effluent discharge, and river watering by livestock, among other factors. According to the survey data, most households in the watershed have pit latrines for the disposal of human and other wastes. It is noted, however, that Nessuit location still lags behind in the area of sanitation due to an inadequate availability of toilets. Some people in the area are known to use the bush or their fields as toilets. This practice has serious consequences on human health because of its implications on the pollution of the river water. In order to avoid possible water contamination and the likelihood of the spread of water borne diseases, the residents should be encouraged to construct and use pit latrines, particularly because of the area's proximity to the source of River Njoro.

5) Agroforestry. Results of the survey show that agroforestry within the watershed is mostly specific to individual household decisions. However, the most common tree species preferred by farmers include grevillea (62%), croton (37%) and cypress (31%). The other species commonly found in the watershed include acacia (19%) and eucalyptus (13%). It is to be noted that the extent of these tree species being grown in the watershed is still quite low. Tree planting by farmers/households requires vigorous promotion through the establishment

of tree nurseries to enable the people to have easy access to forest products that are seriously depleted. The survey notes that problems associated with agroforestry practices include livestock spoilage, lack of tree seedlings, lack of water and lack of technical knowledge.

6) ***Type of Housing.*** Shelter is one of the core values of development. Good housing is, therefore, an important indicator of development in any country/economy. Within the River Njoro watershed, the survey established that the majority of households had mud-walled houses with iron sheet roofing. These house structures constitute 61% of all units within the watershed. Kaptembwo location has the highest number of households with stone-walled houses (however, residents frequently are tenants in this poor neighborhood of Nakuru) whereas Nessuit has the poorest type of housing, with no household having a stone-walled house.

7) ***Household Income and Expenditures.*** The main economic activities in the River Njoro watershed are explored fully in the household survey data set. It is noted, however, that crop and livestock production are the main economic activities of the watershed residents. They account for 68.8% of the people's daily livelihood and constitute the major source of their income. A key feature of the data is that the average per capita income of the watershed population is low. An example is that the average earnings of the people are less than a dollar per day, indicating that the poverty level within the watershed is very high or is equivalent to the United Nations index of absolute poverty. The heavy reliance of the watershed communities on agriculture whose performance has been poor, accounts for the high level of poverty. Survey data indicate that the average monthly household expenditure (exempting education) is Kshs 5,767. This translates to an average of Kshs 29 per person per day within the watershed. The average annual expenditure on education is Kshs 17,338 or approximately Kshs 1,400 per month. This is nearly 20% of the average monthly household expenditure in the study area.

Integrated Modeling and Assessment. A long-term goal of this project is to fully integrate qualitative and quantitative models for watershed assessment and planning, e.g. scenario development. The first step towards developing a useful decision support matrix and toolbox of watershed health techniques is to identify and implement applications appropriate to the test area. In this phase of the research a cadre of models were tested to describe the physical processes governing watershed and ecosystem health. Future research will tie these results in with the outreach (stakeholder involvement) component and provide a coherent and quantitative description of the system from both a biophysical and human-centered viewpoint.

Ecological Model Development: BIOMAT. During the year in review, existing literature on biological monitoring and assessment of water quality was reviewed and suitable biological monitoring models for the River Njoro Watershed were identified and available suitable data for use in the watershed was documented. We evaluated the suitability of ecological models for development of a biological monitoring and assessment tool (BIOMAT) for River Njoro Watershed. Suitable indicators of terrestrial and aquatic ecosystem health were determined from a literature review in the context of extant and potential data. In future years, a tool will be developed using field research and GIS data, including classified remote sensing imagery that will serve as a model for identifying critical and threatened areas susceptible to or in active decline. In the current year appropriate technologies and investigative approaches were evaluated. The objectives of the activity were:

- Review literature on biological monitoring models.
- Identify suitable biological monitoring models for the River Njoro Watershed.
- Collect and document suitable data for use in River Njoro Watershed for developing, testing and adopting a water quality monitoring, and assessment model.

We identified benthic macroinvertebrates and birds as the "community of organisms" for use in assessing, monitoring and mapping stream site water quality in the River Njoro watershed. They provide quantitative water quality measures that can be used

to diagnose water quality at a single site; monitor water quality over time; evaluate the impact of point-source and diffuse-source pollution on water quality; assess benefits resulting from rehabilitation activities; and examine the relationship between land-use and water quality.

However, synthesis of available data to calculate a quantitative measure or index of water quality in River Njoro watershed has not been done. This will involve mainly deskwork and will be completed in the next phase of the project. In addition, mapping of River Njoro water quality using macroinvertebrate distribution and proportion (%) of natural riparian vegetation by GIS tool has been completed and will be used for visual presentation to stakeholders in tiered workshops in the coming research year.

Based on the literature review, availability of suitable data and suitability of the models, it is feasible to develop a Biological Monitoring and Assessment Tool (BIOMAT) for the River Njoro watershed based on the Biological Monitoring and Assessment Program (BIOMAP) developed in Canada by Griffiths (1996). The BIOMAP model was identified as an appropriate application for deployment in the Njoro watershed because:

- It was specifically developed for assessing water resources following a watershed approach unlike other models developed to assess point source organic pollution in rivers.
- The model links watershed land uses to stream water quality.
- It has the capacity to rapidly determine and assess a water quality index.
- Allocation of sensitivity values to organisms ranges from 0 – 4 based mainly on observed distribution following pollution gradients and does not require complicated laboratory toxicity tests.
- Once the water quality index has been calculated, it will be used as an input into a GIS model for mapping water quality in a watershed. The maps will be used to identify stream reaches that are potentially environmentally sensitive or the best sites to concentrate rehabilitation efforts. They will also be used during stakeholder workshops and meetings as visual aids for water quality.

Sampling in support of BIOMAT development and Related Findings. Ecological sampling and modeling occurs at three sampling scales: terrestrial ecology relating to land cover and management; river health and function; and lake health and function. This section discusses findings related to field sampling, laboratory analyses and the manner in which these findings are being used to develop a functional monitoring and indicator-based toolkit to guide management decision making for ecological sustainability.

River Sampling and Linkages to Land Cover and Management. Impacts of upland land uses on the downstream water quality are systematically recorded at 10 sampling sites along River Njoro. The goals of this sampling strategy were to:

i) examine the contribution of nutrients from upstream land uses draining each of the sampling site.
ii) assess whether both the proportion of land uses and the size of subwatersheds account for the variability in water quality in River Njoro Watershed.

Spatial analysis of land cover. Geographical Information System (GIS) analysis was used to determine the spatial distribution of land cover types determined using remote sensing classification techniques (see 2004 Annual report and updated information contained in this report). Standard DEM-based routines were used to establish the watershed contributing runoff to each sampling site. Water and sediment samples were collected for chemical analysis and nutrient levels related to upstream land use types and size of subwatersheds. Table 2 shows the size and proportions of different land cover types in the upper and middle reaches of River Njoro Watershed contributing runoff to sampling sites. There has been a significant increase in the percentage area covered by small scale mixed agriculture and bare land downstream from the uppermost sampled site, Tiriytagoi, to the lower sites around Egerton University. In contrast, there is an overall decrease downstream in the land cover area of grasslands, large scale agriculture and indigenous forest from the uppermost site of the watershed.

The increase in area covered by mixed small

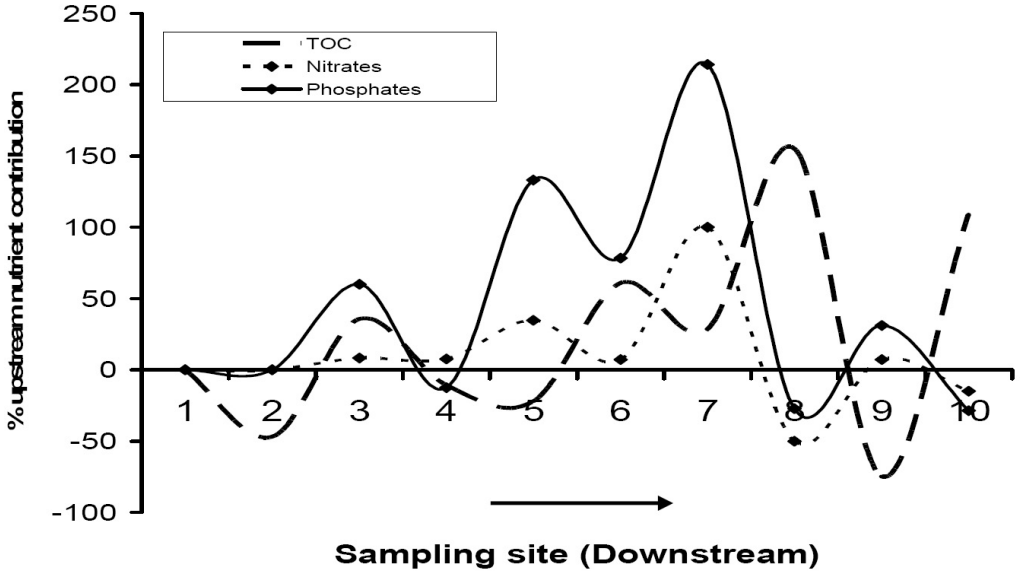
Table 2. The size and proportions of land cover area in each watershed contributing runoff to the sampling sites in Upper and Mid Reaches of River Njoro Watershed. The greater part of forests has been converted to small-scale agriculture and there is large net loss in large scale agricultural systems.

Sampling Site	Subwatershed	Agriculture		Mixed		Bare land		Plantation		Indigenous	Grass-lands	
	Area (km²)	km²	%	km²	%	km²	%	km²	%	km²	km²	%
Tiriytagoi	35.61	1.73	5	5.77	16	1.3	0	1.11	3	19.7	7.19	20
Sigotik	74.54	1.74	2	10.61	14	1.73	0	1.8	2	49.63	10.6	14
Confluence	79.06	1.75	2	14.2	18	1.9	0	2.31	3	50.02	10.6	13
Mary-Joy	118.95	2	2	35.08	29	4.18	0	3.32	3	67.17	10.97	9
Egerton University	119.07	2	2	35.17	30	0.43	0	3.32	3	67.17	10.97	9
Njoro Canning	121.62	2.02	2	37.62	29	0.48	0	3.32	3	67.21	10.97	9
Total	122.5											

agriculture is theorized to be due to an increase in human population and the subsequent extension of tillable land towards the forest reserves and the stream edge by small-scale farmers. This is leading to degradation of quantity and quality of water resources in the River Njoro watershed.

Spatial Analysis of Nutrient Levels. Figure 1 shows percentage contribution of nutrients from upstream land uses to downstream sampling sites during the study. The pattern of percentage contribution of nitrates by stretches of land upstream each site follows that of phosphates. Spatially, the subwatersheds around Egerton University (i.e. between Mary Joy and Bora Milk) accounts for the highest percentage contribution of nutrients to the river. This is expected because the major land use activities around the University include human settlement, small scale agriculture, education institutions, vegetable canning factory and dairy plant which are probably the major point and non-point sources of phosphates and nitrates in the watershed. The main source of phosphate in surface waters comes from wastewater from sewage treatment works. Return flow from grazed grasslands, diffuse fertilized and manured crop fields and wastewaters from the institutions and factories add significantly to the nutrient load to the river. Phosphorus enters the river through sewage inlets

Figure 1. Downstream variations in percentage contributions of phosphate, nitrate and organic matter (TOC) by the stretch of land upstream of each site from the upper most forested site to Ngata the down most site. Note: 1= Tiriytagoi, 2= Sigotik, 3= Confluence, 4= Mary Joy, 5= Egerton University, 6= Njoro Canning Factory, 7= Bora Dairy Plant, 8= Njoro Bridge, 9 = Kenyatta, 10 = Ngata. (Negative percentage implies that the upstream site has concentration greater than the downstream site so that the actual trend is one of decrease.)



and non-point sources, for example washing sites along the river.

Organic matter contribution by land upstream of Sigotik sampling site is low as compared to the concentrations recorded at the forested Tririytagoi site (Figure 1). This is followed by an increase from Sigotik to the Confluence. There is some relatively intact forest along the stream valley at this stretch of the river. Lower levels of phosphates and nitrates were recorded at sampling sites in the stretch of the stream between Bora Milk and Njoro Bridge. This is likely a consequence of the undisturbed dense riparian forest and instream vegetation in this part of River Njoro. The slope of the landscape at this stretch is gentle unlike the upstream fast flowing reaches. Consequently, the slow flow of water allows for a longer interaction time between phosphorus loads reaching the stream, stream bed sediments and biota. Nutrient loss can occur due to adsorption to soil particles and their subsequent sedimentation. In addition, the stretch is surrounded by large-scale farms that pump water from the river and boreholes thereby reducing the need for frequent visits to the river by livestock and people. This allows for development of vegetation along the riparian corridor consisting of terrestrial and aquatic macrophyte plants (e.g. *Potamageton sp., Papyrus sp.* etc). These plants are known to have a cleaning effect on nutrient rich waters. In addition, this stretch of the river has a gentle gradient, which allows for uptake of dissolved nutrients by roots of the aquatic plants suspended in water.

There are significant positive relationships between phosphorus loss and proportion of land cover area of small scale mixed agriculture (R2 = 0.52) and bare land (R2 = 0.55) in the River Njoro watershed. This indicates that the major source of phosphorus contamination of stream water is from non-point sources of small scale agricultural and bare lands. On average the two sources contribute over 55% of phosphorus load to the upper and mid reaches of the river.

The findings in this study support our hypotheses that nutrient and sediment transport are dependent on forest or grass buffer areas between disturbed uplands. Rivers serve as integrators of landscape characteristics and as recipients of pollutants from both atmosphere and the landscape. Proportions of different land uses within a watershed can account for some of the variability in river water quality. The rehabilitation of River Njoro Watershed, therefore, should target management of upland land and near-stream land uses. Conservation and the enhancement of the riparian vegetation along the river channel is another important aspect to be put in consideration in the management of water quality in the watershed.

Lake Nakuru Sampling and Linkages to Watershed Activities. One of the foci of River Njoro Watershed project is the use of water as an integrative environmental indicator of ecosystem function and stress. Anthropogenic activities, including livestock grazing and related issues of sedimentation and pathogen loadings are a major threat to the water quality of natural aquatic ecosystems. Pollution of water within watersheds is accompanied by changes in water chemistry, biodiversity and species assemblages in the recipient water bodies. The watershed outlet is in Lake Nakuru National Park, which has unique water chemistry and is of vital economic importance to the region. An ongoing research effort of SUMAWA is to evaluate the health of the lake and the associated River Njoro Watershed using biological and physicochemical features.

Longitudinal continuous sampling and analyses have been implemented in the river and lake throughout the project at regular intervals to quantify the linkages between watershed health and lake ecology. Samples were collected monthly from sampling sites in River Njoro and Lake Nakuru. The main goal was to identify indicators of river and lake health that can be incorporated into a rapid assessment tool and built into a Biological Monitoring and Assessment Tool (BIOMAT). A BIOMAT will aid future monitoring programs and act as a signal detector and early warning system for significant changes occurring in the lake without the necessity of detailed field and laboratory analyses.

Preliminary results show strong correlations among Lake and River health. Ongoing research related to livestock, agricultural and human uses are expected to provide a more direct link among various management activities and physical properties. At this stage of the project, we are establishing and

Table 3. Mean (±standard error) of nutrient and chlorophyll-a concentration in Lake Nakuru between April 2004 and January 2005.

Site	SRP (mg/l)	TP (mg/l)	NH4-N (mg/l)	TN (mg/l)	Chlorophyll a (mg/l)
Makalia	1.61±0.28	3.2±0.48	0.28±0.04	1.26±0.26	845.5±97.6
Makalia-Nderit	1.60±0.28	3.67±0.50	0.31±0.04	0.89±0.26	686.2±97.6
Nderit	1.56±0.28	3.74±0.49	0.31±0.04	0.79±0.26	811.4±100.5
Metalpole	1.41±0.28	3.93±0.61	0.30±0.04	0.661±0.26	620.8±100.5
Jetty West	1.42±0.28	3.64±0.44	0.27±0.04	1.25±0.27	594.4±97.6
Jetty Mid	1.45±0.28	3.55±0.49	0.28±0.04	1.03±0.27	530.6±103.5
Jetty East	1.48±0.28	3.55±0.49	0.27±0.04	0.64±0.27	755.1±103.5
NjoroWest	1.63±0.28	3.90±0.51	0.24±0.04	1.05±0.26	447.2±10.9
Njoro Mid	1.23±0.85	2.84±0.54	0.07±0.12	0.77±0.26	493.0±114.9
Njoro East	1.45±0.28	3.63±0.39	0.27±0.04	1.32±0.26	508.9±110.9+
Hippo-point	1.52±0.28	3.77±0.44	0.28±0.04	1.42±0.27	421.3±106.9

quantifying land and water characteristics with the short-term goal (2005-2006 research years) of identifying better indicators of management function.

Physicochemical Characteristics. The maximum and minimum depth profiles of dissolved oxygen (DO) concentrations in Lake Nakuru were recorded at the surface and bottom, respectively. The water layer above 20 cm was significantly rich in DO concentration (mean above 10.5 mg/l) as compared to the layer below 80 cm (mean < 5.1 mg/l). Below 1 m depth, DO levels drop to as low as 0.03 mg/l in the interstitial waters. This indicates that the bottom sediments of Lake Nakuru are anoxic and can only support anaerobic mode of respiration.

Water temperatures in Lake Nakuru reduce with depth. A sharp decline in water temperature occurs from the surface to about 60 cm. Between 60 and 100 cm the water layer has almost constant temperature. This indicates that a weak thermal stratification occurs in the lake causing the lower and upper layers of water not to mix.

Nutrients. Table 3 shows mean values for nitrogen and phosphorus nutrients (soluble reactive phosphorus - SRP, total phosphorus – TP, ammonium nitrogen – NH4-N, total nitrogen – TN) and chlorophyll-a concentrations in Lake Nakuru. Overall, there are no significant differences between sites for all nitrogen and phosphorus species ($p>0.05$). Of significance to this project and management goals the highest level of soluble reactive phosphorus (1.63±0.28 mg/l) was recorded at the shore close to the mouth of River Njoro, while the lowest mean (1.23±0.85 mg/l) was observed at the middle site along the Njoro transect. Although TP showed a similar trend, its variability between sites is less discernible. SRP constituted about 50% of TP through out the lake. Among the nitrogen species, NH4-N contributed up to 50% of TN at some sites. This relatively higher ammonia levels are probably due to the high level of productivity and subsequent decomposition of organic matter at the anoxic sediment at the bottom of Lake Nakuru. Figures 5 and 6 show temporal variation in total nitrogen and total phosphorus in Lake Nakuru between April 2004 and January 2005. Whereas the highest total nitrogen was recorded in August 2004, the highest value of total phosphorus was observed in December 2004. Temporal variation

Figure 2. Temporal variation in total nitrogen in Lake Nakuru between April 2004 and January 2005.

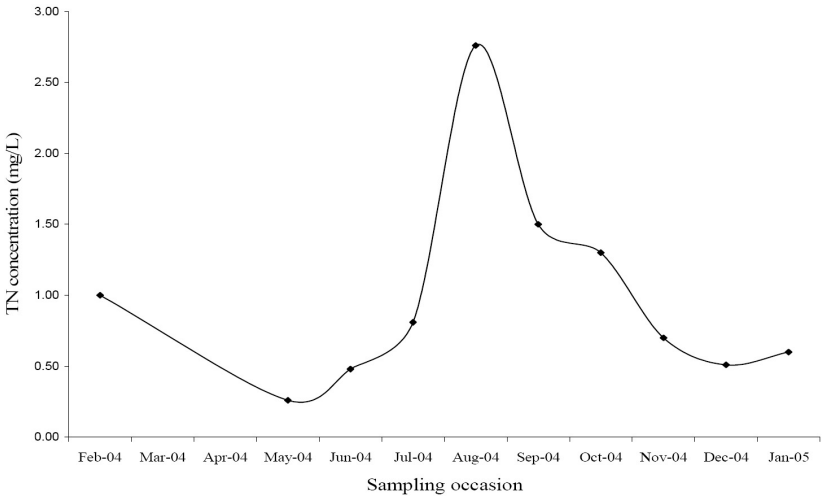
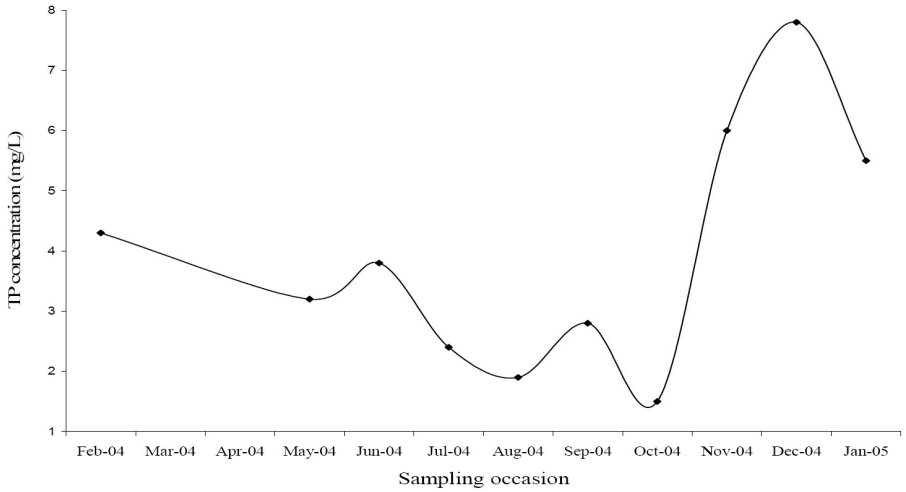


Figure 3. Temporal variation in total phosphorus in Lake Nakuru between April 2004 and January 2005.



in primary production in Lake Nakuru ranged from 400±200 µg/l in February 2004 to 902±192.1 µg/l in January 2005. Spearman rank correlations show that primary production was significantly related to the concentration of SRP (r=0.43; p=0.02) and NO3-N (R=0.44; P=0.01). These relationships indicate that the two species of phosphorus and nitrogen are most important and perhaps limiting primary production in Lake Nakuru. Overall these nutrient findings are theorized to provide a linkage with both management and hydrologic flow regime. Ongoing research aims to link hydrologic modeling with nutrient flux and correlate these findings to management activities in the watershed.

Stakeholder Capacity Building. The purpose of this activity was to build community and stakeholder institutional capacity to dialogue and collaborate in developing actions to address the water quality and quantity problems and the sustainability of economic functions of land and water resources in the watershed. This project is working towards the development and application of community and watershed action plans that will serve as an outreach opportunity and implement suggested interventions. During the coming year preliminary community action plans (CAPs) will be developed in coordination with the ongoing PRA effort that utilizes biophysical and socio-economic research findings. In order to develop appropriate community and watershed action plans it is vital that the capacity of the local institutions and individuals be improved so as to ensure success of the programs.

Stakeholder component planned to involve all stakeholders (communities along the watershed, policy makers and administrators, institutions) in identifying the problems/challenges facing the users of River Njoro. This involvement has been important because it has become common knowledge that communities/stakeholders need to "own" a project for it to be sustainable.

Finalize PRAs in Remaining Communities of Nessuit and Ngata Areas. This activity was to identify stakeholder perceptions, knowledge base, and previous history with watershed interventions. The 2 zones marked out for PRA have been completed (See the SUMAWA Technical Report on "Synthesis of River Njoro Watershed PRA Reports") The aim of the PRA exercise was to engage the concerned communities in effective participation in problem analysis and the development of the relevant action plans for their implementation, monitoring and evaluation. The research team considered this as the best way of ensuring sustainable watershed management of River Njoro. Communities were able to articulate their resource challenges which include inadequate, unreliable and unclean water sources, shortages of fuel wood, poor community cohesion and poor leadership as well as poverty.

The overall objectives, namely problem identification, opportunity assessment, and preparation of community action plans have been achieved to date. One of the observations made during the PRA process was inadequate female participation. This was immediately addressed by a Women Leader's workshop in FY 2003/2004 that

shared the research scientists' results from Phase One and also women's contributions to the project. The workshop attracted 55 women from across the watershed. In the coming year we plan to capture greater involvement in women during stakeholder and tiered workshops as well as the development of a River Njoro water user association.

A summary of the major findings from the completed PRA's shows that concerns related to water quality and quantity are shared throughout the watershed. Sustainability of agriculture and related livestock activities are also of key concern to residents. The primary outcome from analysis of the PRA's shows that:

1) Water quality in River Njoro is poor, and is leading to a series of water-borne diseases within numerous communities. The quality of available water is inadequate leading to insufficient water supplies. This leads to long hours spent by women to fetch water. It also leads to compromises of hygienic practices leading to more infectious and waterborne diseases.

2) Communities used the development of CAPs to formulate opportunities they can exploit to address problems of water quality and quantity. These include harvesting rainwater at individual household levels, sinking boreholes, construction of latrines, agroforestry, law enforcement on water abstraction and riparian protection, formation of water committees among others.

3) Women are the main users of water from River Njoro. Young men use River Njoro water as a commercial product for sale or they are paid to fetch water to various points in the communities. This finding is collaborated by the results of water abstraction studies reported in the document.

4) The river occasionally dries up downstream and when it does, all users are affected. Women and children have to trek further upstream to collect water, young men often lose their commercial engagement and older men stop irrigation activities and walk their animals further upstream.

5) Diarrhea is a major problem with the community; other problems include typhoid and ameobisis.

6) Donkeys are very instrumental in the exploitation of riparian resources and upper zone forested areas. They are also used extensively in ferrying water from the river to the users, especially during the dry season when the downstream sections dry up.

7) Policies in place to manage watershed resources are from the central government. They have been passed on from the colonial government to the current government with cosmetic changes. These policies are ineffective and difficult to implement because the users do not understand them. Another area of concern is that these policies exist mainly on paper as they are very poorly enforced due to lack of enforcement officers.

8) Local cultures are ignored by the central government in resources management. As a result the central administration has not acknowledged customary laws governing water management, riparian resources utilization and general management of natural resources within the watershed.

Policy. So far local administration and various government representatives at the local levels have been involved both when PRAs were conducted and in the stakeholders workshop to launch SUMAWA project. During the Launching Workshop which attracted 71 participants several policy makers or their representatives were in attendance.

Gender analysis. Stakeholders/Outreach components solicits female/youth participation at all levels. The poor water quality and inadequacy of the same affects women and children more than men. Hence the benefits of improved water quality and quantity would mean fewer visits to the clinics, and less cost of sickness, time saved from collecting water and constant source of income for those youth who engage in the sale of water.

Long-Term Monitoring Program for Water Resources. A stated long-term goal of this project is to develop the River Njoro Watershed into a fully instrumented experimental watershed suitable for assessing the impacts of interventions on the biophysical components of the watershed. Equipment for a series of automated sampling systems has been acquired and will be used to collect data at established points throughout the watershed to continuously monitor rainfall, runoff, and water quality. These stations will be critical in key areas:

- They will provide spatially distributed data for enhanced and accurate hydrologic and water resource modeling and prediction.
- They can serve as vital links between SUMAWA and local communities through mechanisms of training, data acquisition and information exchange.
- They will be barometers of change and provide quantitative measures for assessing impacts of interventions and changing land cover and land management practices.

Rainfall. During the assessment phase, it became apparent that there were only a few rainfall stations with sufficient data within the watershed. These stations were also very unevenly distributed. As a result it became necessary to set up new stations which would be used to generate weather data within the watershed. This was done in conjunction with the local stakeholders particularly schools, officers of the Provincial Forest Department and technical staff from the Kenya Meteorological Department.

Four new standard daily rainfall monitoring stations have been established in the watershed, with the assistance of the technical staff from the Kenya Meteorological Department (KMD). They are located at local schools and a forest station in the upper watershed. The stations were enjoined into the Kenya Meteorological national network. These rainfall stations will serve as an opportunity to engage young people in the research effort and enhance environmental awareness.

The installation and monitoring of these gauges has been treated as a training and outreach opportunity. Mr. Munyendo from MET HQS Nairobi teamed up with members of the SUMAWA research team and involved locals and students in the siting, construction and data capturing. The exercise involved site selection which was free from tall trees, installation and calibration of the various rain gauges and also the fencing of the sites. Data collectors were recruited from the community and trained on how to read, record, and compute the data. Standard recording sheets were supplied by the MET Staff and provided to the readers in all the four stations.

Two tipping-bucket style rain gauges have been acquired and installed at secure locations. These tipping-bucket gauges are used to measure the distribution of rainfall during an event and are more useful to hydrologic interpretation than the more traditional single-capture methods described above. Data loggers continuously capture data for the tipping-bucket gages and are downloaded on a bi-weekly basis.

Outreach and Information Exchange. Rainfall monitoring in any locality is vital because it helps land managers and farmers to predict the rainfall patterns. This is of critical importance in deciding when to plant crops, as well as harvesting under non-ideal conditions and in timing land preparation. The same applies to tree planting within the watershed. In order to enhance rainfall measurement, prediction and information transfer, SUMAWA has facilitated four communities in that the gauges are monitored, protected and managed by the community. This empowers the community since they take ownership of the data and can use it for their own needs. At the same time, this data is available for the SUMAWA project and also to the MET Headquarters Nairobi, where it is sent monthly.

Assessment of Groundwater Resources. Basic information on the existence of registered boreholes in the watershed was obtained from the Ministry of Water and Irrigation. Groundwater is the most important (most affordable and dependable) source of developed water supply for agricultural, industrial and domestic uses in the watershed, providing a natural underground system of storage, distribution and filtration of surface water. Its sustainability linked to land use changes in the Njoro Watershed is a uniformly serious concern of stakeholders. A major information gap was identified during this exercise: virtually no data are available that represent changes in the groundwater over time. Such information is necessary to establish groundwater flow patterns, stream-aquifer interactions, and groundwater discharge/recharge zones. Little knowledge also exists of the type and extent of the aquifers in the watershed. A field sampling strategy was established in which borehole sites will be identified and geo-referenced not only for long term observations but also for full hydro-geological studies of the watershed area.

A groundwater depth monitoring tool was

purchased for this phase of the project. A lack of physical infrastructure capacity was identified as a major impediment to this phase of the project. An informal agreement has been made between SUMAWA and the Ministry of Water in which the Ministry exchanges information on borehole location and provides access to these sites while SUMAWA provides data to the Ministry on groundwater depth. This relationship has proven very satisfactory as SUMAWA researchers are able to better identify and measure water resources and the Ministry is provided with critical information that has significantly restricted their ability to plan and manage for groundwater resources and the sustainability of water supply systems in the area.

Linkages to Community-Driven Needs.

Extension of Egerton University Pond Aquaculture Project into Local Community. One of the principle hindrances to economic development in the River Njoro watershed is the overwhelming dependence on maize production. By introducing other mechanisms or economic and food security we intend to demonstrate the importance of diversification and alternative agricultural practices. During the 2003/2004 research year an appropriate site was identified and permission to use it was sought and obtained from Egerton University management. Four functional demonstration fish ponds have been constructed at the Njoro Campus of the University. This interdisciplinary project drew on team members from the Fisheries Department, Moi University and Egerton University, including members from each project component. The tasks embedded within this multi-year activity are:

(a) identify appropriate pond location and acquire land rights from the University;
(b) construct the ponds. In this phase the design of the ponds was to be overseen by team members from Moi University, while the actual construction of the ponds was to be overseen by the team members from the Fisheries Department;
(c) outreach and demonstration of the project to community leaders, farmers. This activity was to be driven by team members from the stakeholders' involvement team and serve as the initial phase of outreach and technology transfer;
(d) track and analyze the economics of the pond demonstration site. It will be essential to fully account to the costs associated with aquaculture. It is hypothesized that aquaculture can provide for a significantly greater return on investment than other agricultural practices in the watershed, and a comparative economic analysis is required to test this hypothesis and provide a foundation for outreach and technology transfer; and
(e) track and analyze impacts on water resources. One of the major drawbacks to aquaculture in this watershed is that the region is water-stressed in terms of both quantity and quality. The watershed team will quantify the impacts of the project on local water resources.

In order to test the feasibility of constructing the ponds while coordinating efforts among institutions and the local communities' four fishponds were constructed at Egerton University. Construction involved extraction of soil from the pond at higher elevation and off-loading the soil to the second pond on lower elevation to constitute the dykes. The soil texture was noted to be porous and dykes reinforcement was therefore necessary. The extracted core trench were therefore filled and compacted with clay soil. The clay soil was imported from Biston and an area within the University premises.

Effective pond management started on October 2004. Water was filled in one of the ponds to observe the rate of seepage. The results on the pond management were to be replicated to the other three ponds. The pond water retention capacity was observed to be very poor due to probably high permeability of the soil. Clay was used to reinforce the pond bottom and inner surface of dykes. After clay compaction water was once again filled. Though the water retention capacity improved a little, the water was again lost when the flow into the pond was stopped. Towards the end of the year 2004, the ponds had not completely stabilized to allow stocking of fish. Between January and February, the ponds have been found to show some degree of stability.

A major success of this project was the

development and execution of extension services/ stakeholders involvement with the Mukeu and Ufunuo Community based organizations in the neighborhood of River Njoro watershed. These communities gained exposure to the ponds and self-identified an interest in developing fish farming within their communities. They acquired the ponds construction technology through practical extraction of ponds at Egerton during the construction phase. They were also lectured on ponds construction art and design at the site by the Fisheries Department. A follow-up was instituted to monitor their activities. They have now constructed ponds and are developing a going concern in this agricultural alternative.

Activity 2: Reorganize the research management structure in Kenya and consolidate the research team

The primary goals of this activity were to (a) perform a project review and reorganization of the management structure, (b) Enhance linkages across US-Kenya research platform, (c) based on previous two findings develop and submit Phase II research activity plan for 2004-05, and (d) identify and hire a project administrator at University of Wyoming.

In all cases this activity has been completed to satisfaction. The project review was performed in coordination with the GL-CRSP Management Entity (ME). Dr. Miller and Jenkins accompanied Dr. Demment and Susan Johnson of the GL-CRSP ME to Kenya in Fall 2004 to initiate the process. From Oct 2004 – May 2005 no new research initiatives were undertaken, although core components of the project were maintained such as student support and field data collection. Susan Johnson traveled to Kenya and worked in the SUMAWA office for a month in Spring 2005 for the purposes of improving office function and helping with project management. Drs Miller and Jenkins returned to Kenya in Spring 2005 to finalize this activity.

Adaptive project management. With respect to the management capacity and leadership, an analysis was performed in which we identified our strengths, weaknesses and opportunities available to address the weaknesses and enhance our strengths. The centralized management structure implemented by SUMAWA in the first year of the project was identified as a blockage in the free flow of communication and information within the project. This historical model was replaced with an updated decentralized management structure that reflects the emergent needs and direction of the project. Examples of these changes include: (1) A project coordinator has been hired and located in the main SUMAWA office (Dr. Patterson Semenye), (2) a project coordinator (Laura Dalles) was hired at the University of Wyoming and officially added to the project in July 2005 to directly liaise with Kenyan counterparts, and (3) Free flow of communication has been established, and (3) Equipment and infrastructure has been identified, purchased, and transferred to Kenya researchers to allow for PIs, students and other collaborators to operate more efficiently independent of location. Strategies employed in this endeavor include the acquisition of cell-phone technology-based internet communication (allowing for internet access from anywhere with cellular reception) and adopted practices for communication exchange.

Activity 3: Identify and recruit new researchers as needed

The objectives of Activity 3 were related to (a) identifying Kenyan researchers with qualifications related to the future research activities, both within and outside the current partner institutions in Kenya, (b) write-up and distribute the Request for Qualifications (RFQ) documents for recruiting new researchers, and (c) evaluate responses to RFQ's and select RAP researcher leaders for Phase II.

A series of interviews and informal interactions with scientists at various Kenya institutions has expanded the network of expertise that may be potentially added to this project. For example, additional expertise has been identified as a need for economic trade-off modeling, human health, and water resource modeling. The procedures for adding new scientists to the project have been drafted and agreed upon by SUMAWA researchers. The draft RFQ's have been written for two of the research activities planned for the upcoming FY 05/06 year.

Activity 4: Maintain on-going core project functions in Kenya

Development of a toolkit for participatory management of rural watersheds in Kenya. Effective public participation is a foundation for sustainable watershed management, yet there are no demonstrated methods for or examples of its achievement in tropical semi-arid rural grassland watersheds of Kenya which support critical downstream water services. Within the SUMAWA project, a set of tools has been developed and tested to engage local communities and stakeholders in a dialogue and decision-making process to improve the development and management of the River Njoro Watershed in Kenya and reverse declining water quality and quantity problems. A toolkit manual based on the experience is under preparation for general distribution.

Participatory Rural Appraisal (PRA) data gathering (community map; benefits analysis; resource flow chart; seasonal calendar; institutional analysis), problem analysis (problem list; causes and coping strategies; trends; pair wise ranking matrix), and opportunity assessment tools (opportunity listing, assessment, and ranking; action planning) used in Kenya in development work were modified and adapted to focus on river problems in the River Njoro Watershed. Professional facilitators, accompanied by project scientists, led a series of two-hour discussions with a group of 25-40 community representatives over a two-week period in 2002-2003 in five communities residing along the river. Outcomes were documented and synthesized.

The discussions revealed 19 different common pool resource uses of in-river water, river bank/bed materials, and riparian buffer vegetation by local community members and other actors in the watershed. Livestock-related uses were high on the list and widespread. These uses were shown to be critical for meeting very basic domestic human and livestock needs, and supplementing income for economic survival. The discussion tools also influenced stakeholders' perceptions and attitudes as they went through the process of learning and enriching each other's knowledge base. A unifying theme for action emerging from the process was the protection and rehabilitation of the riparian buffer zone which has been badly undermined by population pressure and lack of management as illustrated in the list of common themes for community action shown here:

- Restoring and protecting the riparian buffer reserve (zoning riparian areas)
- Local enforcement of laws on river pollution (e.g., community patrols)
- Education, awareness raising, and training on need for and rules to protect riparian buffer, trees and river water
- Infrastructure rehabilitation and new construction for water supply (livestock and human) and sanitation
- Agroforesty and riparian tree planting programs
- Developing a riparian management plan for the watershed
- Clarification and enforcement of laws governing water abstractions from the river

The next challenge in the public participation process will be development of local rules and enforcement mechanisms to protect the riparian corridor when water, fodder, and other riparian materials are considered open-access resources.

In summary, a toolkit has been developed and preliminarily tested that demonstrates achievement of community participation in the sustainable management of watersheds in Kenya. The tools provide a process for identifying local communities' perceptions and priorities for watershed management and common objectives and options on which a watershed-wide action plan can be built. The study has also demonstrated how partnerships between communities, scientists, policy-makers and other stakeholders can be built which are likely to lead to opportunities for locally-based cooperative action. The results will be used in the next stage of the SUMAWA public participation process to blend communities' indigenous knowledge with modern science and technology to identify and select specific rehabilitation and management actions for the riparian zone along the Njoro Watershed in a series of tiered watershed-wide workshops.

Improved Multi-Scale Quantification of Land Cover and Change Over Time. In developing nations such as Kenya, where resources are scarce and increased population pressures create stress on available resources, methods are needed to examine effects of human migration and resultant changes in land cover. Widespread availability and low cost of remotely sensed imagery and Geographic Information Systems (GIS) are making such methods a reality to develop quantitative resource mapping and land cover change detection in developing nations. However, other projects are in agreement with findings from our previous research year that serious difficulties arise in tropical regions when trying to analyze vegetation using traditional methods developed in temperate zones that rely on vegetation spectral bands or indices such as NDVI because saturated pixels limit spectral distinction.

In the past year efforts were focused on improving the land cover classification of imagery that encompasses the Njoro watershed, the watershed itself, and the uppermost regions of the watershed. This multi-scale approach allows for the spatial analysis of influences across space and time which will yield information relating to land use and management, external pressures and potential migration corridors or access points for livestock.

As reported in previous years, we had been able to achieve only 41% accuracy with unsupervised classification; errors were most frequent in distinguishing agricultural lands from grasslands. This has serious implications, as response to land cover change is not linear. In this year a shift in research and application emphasis was placed on band separability and improved geo-rectification of imagery based on secondary sources and a departure from traditional classification techniques. The current classification (Table 4) showed significant improvement, with an overall jump in accuracy to over 75%; the greatest error was in classifying Barren areas. Barren areas in the region change seasonally and annually, so the error is not surprising given that ground truth data collection was impossible on the acquisition date of the Landsat image. Shrublands and Riparian area were classified as Agriculture and Forest respectively. In all cases of misclassification, at least one adjacent cell was classified as the accuracy assessment point. Several points were collected using a range finder and calculating the location, rather than collecting an actual GPS coordinate at the point due to inaccessibility. All misclassified Grasslands cells were classified as Agriculture or Forest and located near transitional areas.

We believe the classification accuracy, using the bands and enhancements indicated above, was much higher than indicated. Refining the classification process by incorporating ancillary data will improve results in Riparian and Agricultural areas. Classified land cover scenes are input to GIS-based models as part of a systems approach to understanding watershed dynamics. Therefore, developing accurate classification methods in rapidly changing tropical landscapes is critical, as migration into these fertile areas puts pressure on scarce resources. These findings were presented at the XXth International Grasslands Congress in Ireland and were published in an accompanying peer-review manuscript. These findings also were the basis for the successful defense of an MS thesis at University of Wyoming (Ms. Tracy Baldyga).

Results of the multi-scale

Table 4. Error matrix resulting from accuracy assessment.

Land Cover Class	Map Total	Number Correct	Producer's Accuracy	User's Accuracy
Open Water	5	5	100%	100%
Urban	3	2	67.00%	67.00%
Agriculture	33	21	64.00%	81.00%
Barren	10	1	10.00%	10.00%
Forest	25	15	60.00%	79.00%
Grasslands	95	86	91.00%	78.00%
Wetlands	—	—	—	—
Riparian	1	0	0.00%	0.00%
Shrublands	1	0	0.00%	0.00%
Total:	**173**	**130**		
	Overall Accuracy:	**75.14%**		

Table 5. Land cover change at a range of spatial scales as determined using remote sensing.

Land Cover Class	1986 – 1995 Nakuru Dist	1995 – 2003 Nakuru Dist	1986 – 2003 Nakuru Dist	1986 – 1995 Watershed	1995 – 2003 Watershed	1986 – 2003 Watershed	1986 – 1995 Uplands	1995 – 2003 Uplands	1986 – 2003 Uplands
Grass	944	1507	2450	-1074	1409	335	130	376	506
Basalt Vegetation	41	-364	-322	0	0	0	0		
Dense Vegetation	-3230	-32854	-36084	-925	-1061	-1986	-881	-1102	-1983
Acacia	995	-316	679	2	7	9	-1	0	-1
Euphorbia	-204	1208	1004	-4	-1	-5	1	-1	
Plantation	7972	-6994	977	806	-1270	-464	733	-1075	-342
Riparian	11	-8	2	144	-141	3	127	-151	-24
Salt Flats	253	-421	-168	3	-4	-1	0		
Urban	571	225	796	142	179	321	0		
Degraded	-139	12258	12119	95	-621	-526	-20	174	154
Large-scale Ag	-13936	-43082	-57018	-374	-2191	-2565	87	-51	36
Small-scale Ag	11726	65935	77661	1179	3638	4817	-175	1830	1655
Water	-313	376	63	7	5	12	0	0	0
Algae Bloom	0	16	16	0	0	0	0	0	0
Error	-1058	54	-1004	-6	1	-5	0	0	0

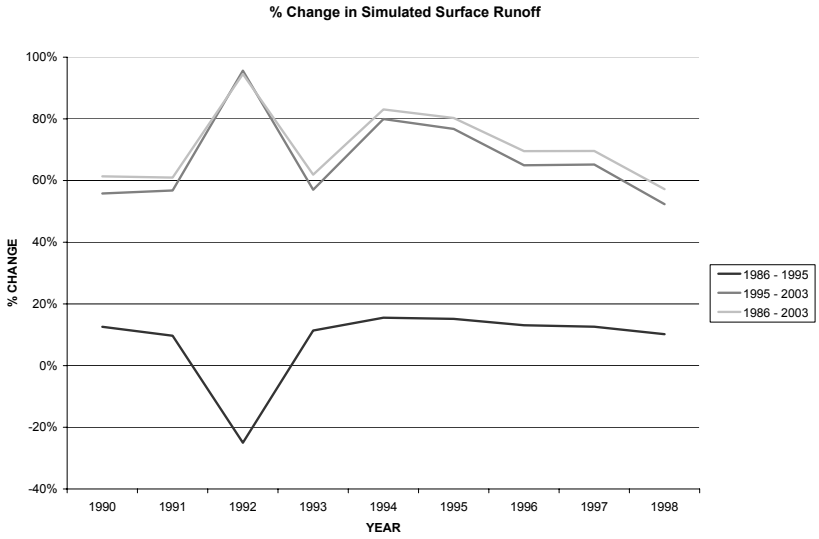
spatial and temporal analyses for three images separated across the time in which the most rapid and profound land cover changes occurred are presented in Table 5. Based on these data, at the district level there has been a 49% increase in small-scale agriculture and a 3% increase in managed grasses between 1986 and 2003 coupled with a 30% decrease in dense vegetation. Within the uplands region, however, there has been a much greater conversion of land cover into small-scale agriculture and managed grass, 82% and 27% respectively. During the same period the uplands region also saw a decrease in dense vegetation and plantation forests by 36% and 22% respectively. Land use and land cover change is greater after 1995 than between 1986 and 1995. For example, managed grass increased by only 9% between 1986 and 1995, while it increased by 20 percent between 1995 and 2003. This is similar for dense vegetation where it decreased by 13% between 1986 and 1995, but decreased by 20% between 1995 and 2003.

Also of particular note is that changes are occurring on a larger scale within the uplands region than at the district or watershed scale. For example, urban and small-scale agricultural areas are increasing moderately at the district and watershed levels, but are nearly doubling during the same period for the uplands region. Land cover results reported here will be linked in as part of a future study that analyzes large-scale migration of people into the watershed from surrounding regions.

Hydrologic Modeling for Strategic Planning and Assessment. Hydrologic modeling is one method used to test the sensitivity of watershed response to land use and land cover change. For the United States, the Automated Geospatial Watershed Assessment tool (AGWA) has gained widespread acceptance among government agencies, researchers, and applied scientists including the US-EPA. AGWA is a GIS-driven suite of tools for distributed hydrologic modeling. One tool from this suite, the Soil and Water Assessment Tool (SWAT) is used to analyze rainfall and runoff response under historical land use and land cover conditions derived from remotely sensed imagery.

This component of the research is directly tied to ecological and stakeholder-desired outcomes. Thus far, the PRA process has identified several broad water uses within the watershed: domestic, livestock watering, water collection for sales, irrigation, commercial and domestic laundry washing in the main river and its tributaries, and religious baptism. Community members voiced concerns over water resources at several PRA meetings held during 2003 and 2004. Two principal perceptions raised in this forum were: (1) increased population has led to water quality deterioration such that water borne diseases incidence (typhoid and other diarrheal diseases and malaria) have increased, and (2) that many community members are without access to sufficient water supplies because they perceive that the river goes dry more often.

Figure 4. Percent change in average total annual direct surface runoff simulation between each of three previously discussed land cover maps.



Data collection for this project included land cover change, soil mapping, rainfall, and runoff. Rainfall and runoff were subsequently analyzed to identify years with overlapping daily data. Only years 1990 – 1998 were identified as appropriate model inputs. The model was run using the same rainfall record over the three land cover maps developed for this project. This approach allowed a focus on hydrologic response to LULCC. SWAT was calibrated on nine years of historical data (1990 – 1998) using the 1995 land cover map.

Thirty calibration simulations were run to identify parameters for final simulations. A problem in field data was identified that had an impact on the calibration effort: runoff data were not collected during the rainy seasons in 1997 (121 days). Consequently, the 1997 annual runoff data was excluded from the calibration. As an indication of problem severity: 1997 was the highest recorded rainfall during the simulation period, but it had a lower-than-average recorded runoff volume. The final calibration accuracy measure using monthly data [Nash-Sutcliffe (R2)] for the calibration plot was 0.7. If 1991 is excluded due to concerns regarding the quality of runoff data during a high rainfall year, the Nash-Sutcliffe R2 jumps to 0.9. There are concerns over the 1991 discharge data collected at gage FC05 because it was an average rainfall year with complete daily discharge and rainfall records; however, discharge results are quite low when compared to average annual rainfall and runoff form historical records. These results are highly satisfactory and provide justification for using the identified parameters as input to hydrologic modeling efforts.

Simulated rainfall-runoff results for 1986, 1995, and 2003 land cover show increased direct surface runoff using the same rainfall as input for all simulations after model calibration (Figure 4). Further analysis indicates that the greatest increase in runoff has occurred post 1995. As a function of land cover change, between 1995 and 2003 simulated runoff increased by more than 50% for each simulation year with most years showing an increase by at least 60%. Spatial variability in runoff changes throughout the uplands region. Several areas, for example in the dense indigenous forests, show improvements through time. However, these areas have such low runoff potential (often less than 1 mm) that any change appears significant when

viewed as percent change. This spatial variability in runoff is 'washed out' at a watershed outlet because total runoff measured at the outlet may not show a significant change through time. This is caused by surface runoff increases in some subwatershed elements, coupled with compensating decreases in surface runoff in other subwatershed elements. Such compensation can disguise problem areas within a watershed when analysis is performed on a gage at the outlet.

An analysis of the spatial distribution of percent change in surface runoff indicates areas near the outlet that were plantation forests in 1995 but altered to small-scale agriculture and managed grasses in 2003 are showing the greatest increase in runoff production. Such increases are to be expected in areas where deforestation and agricultural intensification are occurring simultaneously. Several significant basin scale changes can be attributed to deforestation. Annual flows generally increase in a magnitude proportional to the amount of deforestation.

Identification and Assessment of Public Access Watering Points and Water-borne Disease Risks. An inventory of 38 public access water points along the river was completed. These points include locations where households fetch domestic water supplies to carry home and where livestock are watered simultaneously. Other activities occurring at many of these sites, especially in the more populated middle and lower sections of the river, include washing laundry, children bathing, washing bicycles and cars, and commercial collection of water for distribution and sale or for productive activities such as construction, drilling, etc. Untreated or poorly treated wastewater discharges are numerous and at times make up a significant portion of the stream flow in middle and lower sections of the river during the dry season. A survey of users at these sites was conducted to identify disease burdens, and environmental health conditions of households who depend on the river as their main source of water. Reported diarrhea incidence in the preceding two weeks was highest in Nessuit with 19% of households with children reporting a case of child diarrhea, followed by the Mwigito-Njokerio area with 15%, Njoro Town/Rumwe with 13%, and Kaptembwo/Barut with 11%. Of those river uses in the survey, 30% use river water for drinking purposes with the remaining 70% using other sources. Availability and access to improved water sources is worse in the areas with the highest child diarrhea rates. Of those households with children drinking river water, child diarrhea rates were 22% compared to 9% among households using piped water for drinking, 8% among households using roof-collected rainwater, and 13% of households using borehole water. Only households in the Nessuit area reported having no toilet facility, at 35%. Poor drinking water storage practices and little awareness of alternative methods of in-home drinking water treatment to reduce risks from consumption of contaminated river water were identified as potential areas where outreach and low-cost interventions could be engaged to reduce disease burdens and improve health conditions among watershed residents. Research to monitor and evaluate the pathogen levels and identify sources of river pollution for human and animal health and identify and test appropriate interventions to respond to the significant disease burden associated with domestic water supply conditions in the watershed, a priority community problem among watershed stakeholders, is planned for the coming year.

Activity 5: Consolidate research outcomes to date and translate learning into knowledge and informational products for stakeholder and research dissemination

Research objectives in this activity were related to (a) global and Kenya inventory and desk evaluation of in-home ("point-of-use") low cost drinking water treatment technologies, (b) initiate research into net present value economic analysis of the upper catchments farming systems, (c) improved calibration and validation of hydrologic models, (d) estimation of landscape ecology metrics from available data sets, (e) processing and analysis of historical and project monitoring climate, rainfall and discharge data sets, (f) refine WEAP model parameters, characterize preliminary assessment of current and 10 year water supply and demand situation, and identify critical information and data

gathering gaps, (g) improved classification of remote sensing imagery.

Work related to the point of use drinking water treatment has primarily been focused on a literature review and determination of acceptable technologies. Research in economic valuation is ongoing. Preliminary estimates were extracted from household data surveys, but these data have proven to be relatively error-prone and are still being reviewed for consistency. However, general trends have been identified relative to the economic strategies of people in the watershed as determined by their longitudinal arrangement (upper watershed to the outlet). Livestock have been found to be a ubiquitous presence in the watershed and of profound importance to the economic stability of households and communities. Furthermore, the impact of pastoralists is primarily confined to the upper watershed, while household and small livestock are well represented in the middle and lower sections.

Model calibration of the Soil and Water Assessment Tool has been successful. Calibration efforts have improved prediction to a Nash – Sutcliffe r2 of 0.70 for the 1990's. If the suspect year 1991 is removed, the calibration improves to 0.90. These data were presented in a MS thesis at the University of Wyoming (Tracy Baldyga) and successfully defended (see previous section of this report for details).

Landscape ecology metrics have not been performed due to the lack of classified remote sensing data. These data were finalized too late for inclusion in this research year and will be used in the upcoming research year. WEAP model parameters have not been addressed to date, although efforts are currently underway in Kenya.

Activity 6: Assess decision support framework and develop preliminary method for model integration

Research objectives in this activity were (a) Framing the set of watershed natural resource management policy questions of significance in the Njoro Watershed, (b) Preliminary identification of data requirements within and across models and data linkage issues, and assessment of data availability for component model development.

This activity has been initiated (see information in Activity 1 for more information). A sub-group of researchers has been working together to identify the critical research needs as defined by both stakeholders and policy makers. No documentation of the potential scenarios have been developed pending completion of the analysis of household data and tiered workshops wherein information will be compiled from local communities and institutions regarding goals and objectives.

The preliminary data requirements have been fully determined from the RUSLE, WEAP, SWAT, and Trade-Off models. Ongoing efforts are being made to identify the specific inputs to the BIOMAT tool, and it is expected that these will be finalized in the next research year (in fact, this is listed as an activity in the 2005/2006 work plan).

Activity 7: Information exchange, technology transfer and capacity building

Research objectives in this activity were (a) Attending relevant symposia, conferences, or congresses and (b) Preparing draft manuscripts for submittal to international peer-reviewed journals.

SUMAWA scientists have attended conferences in four countries (US, Ireland, South Africa, Kenya) and have delivered oral and poster presentations at relevant local symposia and regional conferences. In addition, numerous invitations have been extended and accepted for presentation at academic or policy forums. An abbreviated list of these venues includes

- GIS in the Rockies
- International Grassland Congress
- American Society of Civil Engineers Conference
- Society for Range Management Annual Conference
- Willow Park Conference
- University of Wyoming Graduate College Symposia

Overview of Upcoming Research Activities. Livestock play a central role in the economic structure of the Njoro watershed and surrounding region

and act as a barrier to economic shock; research in the watershed has shown that the overwhelming majority of households in the watershed manage for livestock. SUMAWA researchers have identified that large numbers of grazing animals occupy the upper part of the watershed, especially in the large pasture and forested sections, while dairy operations and dense numbers of small browsers are common in the lower sections of the watershed. Livestock are implicated in negative watershed health measures such as soil slumping and erosion, as well as water-borne pathogens. In the past year attention has been drawn to the occasional but intense utilization of the watershed by pastoralists (Maasai) who move their livestock down from the Rift to the valley floor. These actions are a disruptive and potentially destabilizing activity, although there are secondary economic benefits to their presence such as availability of inexpensive milk and meat products. Thus, livestock are viewed as having both negative and positive impacts on the watershed and our operating models and this coming year's work plan are designed to assess the trade-offs of livestock and other forms of economic activities (e.g. pond aquaculture and alternative agriculture).

As in previous years, SUMAWA research activities will be performed under the auspices of four research components: watershed hydrology, ecology, stakeholder engagement, and socio economics. The watershed hydrology group is leading the research focus on hydrologic and climate sampling as well as the development and modification of functional water models such as the Soil and Water Assessment Tool, the Water Evaluation and Planning Tool, the Revised Universal Soil Loss Equation. The ecology group will maintain a sampling strategy designed to develop indicators of watershed and river function using macroinvertebrates, birds, and landscape ecology metrics, with the outcome from these studies being the development of a functional Biological Assessment Tool. The socio-economic group will undertake additional field sampling for economic activities including focusing on livestock and large operations with the goal of finalizing the parameterization and function of the Trade-Off toolkit, which is a project linked with the Soil CRSP. Finally, the stakeholder group will continue their efforts at linking research and local stakeholders and policy makers, including the creation of appropriate informative materials generated from the biophysical and economic components, and holding tiered workshops and research/stakeholder forums.

Several important topics have emerged from the previous two years' field efforts that will be addressed in this coming year's work plan. For one, the loading of fecal coliform in the river was considerably higher than anticipated, and water quality (in the form of N, P, coliform, sediment) was elevated even in the upper sections of the river, which was previously thought to be relatively pristine. This degradation is hypothetically linked to the presence of grazing animals, and this hypothesis will be addressed in the current year. Experimental genetic tools have shown promise in distinguishing between human and cattle-borne coliform, and research associations have been formed with experts in the US to follow up on evaluating the partitioning of human and animal source pathogens in the water system. Hydrologic modeling results have been strongly aligned with stakeholder perceptions in terms of water resources but the relative impacts of land cover transition and land use choice (e.g. grazing pasture vs. agriculture vs. forest) on surface and ground water resources remain unclear and need to be subjected to more intensive evaluation if appropriate information is to be transmitted to stakeholders.

Given that field and modeling efforts have matured along with the biophysical characterization and interpretation of the watershed dynamics, it is appropriate that outreach and stakeholder engagement practices be developed. In the coming year a series of engagement processes will be undertaken, including the creation of appropriate research briefing materials, research/stakeholder/policy maker workshops, scientific meetings, and tiered workshops with watershed communities. In order to gauge the effectiveness of our information exchange and recommended practices a baseline survey of perceptions will be compared with post-exposure surveys and form the basis for future engagement techniques.

In sum, SUMAWA researchers have a full suite of biophysical and human-related research for the purpose of creating a comprehensive watershed

model that may be translated and transferred to stakeholders and policy makers who are the primary determinants of watershed and human health in the Njoro watershed.

Gender

There are three tiers of gender activities and related efforts in the SUMAWA project. The first level is the inclusion and significant participation of women in the project. Of the eight PhD-holding research scientists on this project, three are women. Dr. Lois Chiuri was recently elevated to hold the position of "Leader in Gender Mainstreaming" within the SUMAWA project and invited to participate as a full member at management and PI meetings. In addition, there are several women holding positions of responsibility in research and acting as graduate students. SUMAWA is committed to identifying and recruiting capable women, especially in areas that are historically under-represented. For example, women are in leadership roles in engineering (Dr. Jenkins) and economics (Dr. Mooney and Ms. Njeri) and we have recently finished a female MS student in the male-dominated field of remote sensing and watershed modeling (Ms. Baldyga). In the coming year SUMAWA will maintain these gender-related policies.

The second level of gender activities concerns the collection and analysis of field data. In the last year the SUMAWA team collected sex-disaggregated data. In the coming year analyses will continue related to gender roles and the identification of sex-based economic opportunities or barriers. SUMAWA research findings show that women in the River Njoro Watershed are centrally responsible for domestic water supplies, family health and hygiene, firewood collection, and carry out important roles in both farm and non-farm household income production activities that have implications for the sustainability of watershed resources. Furthermore, a larger portion of poorer households in rural and urban areas tends to be women-headed, further illustrating the importance of building gender and sex-based analyses into economic analyses.

The third level of gender activities relates to stakeholder engagement and research linkages in the communities. The stakeholder outreach component of the work plan and SUMAWA activities has a strong gender component. Efforts have been initiated towards incorporating gender-based activities into watershed health assessment as an outcome of the previous years' stakeholder data collection in which sex-disaggregated data were collected. Gender analysis is included in the participatory rural appraisal methods being used during the assessment phase with communities in laying the foundation for stakeholder involvement in managing the watershed. Exposure visits and planned outreach activities will be constructed so as to encourage the participation of women, and stakeholder training workshops will assure that diverse stakeholder interests, perspectives, and impacts, particularly for poor households, are represented in developing interventions and management plans for the watershed.

Policy

One of the primary research thrusts in this project is stakeholder involvement and outreach. The problems inherent to the Njoro were initiated at the highest levels of government in the form of political favor for support. Thus, the question of public policy involvement is central to understanding the mechanisms controlling land tenure, management, and stewardship. Understanding the different local and regional issues is germane to establishing successful linkages among science, policy, and land management since decision-making must account for realities on the ground. In the coming year stakeholder-driven activities will revolve around policies and legalities governing the watershed. Human health, economic, and water resources analyses will be completed in the coming year. The outcomes from these activities will be shared with both regional and national policy makers.

A potentially significant intervention is planned as related to policy in the watershed. The recently enacted Water Act allows for local communities to create a watershed group with primacy in determining strategies for long-term sustainability and utilization of water resources. SUMAWA is planning to help local communities enact a watershed action group, which will be a conduit

for linking people with policies. Over the past decade, the Kenyan government has issued a series of environmental rulings and legislation that are fundamentally shifting the dominant paradigms of natural resource management. Members of the research team will be responsible for assessing the usefulness and applicability of these laws within the context of the watershed and the potential for empowering local communities and stakeholders for greater control over basin resources.

Outreach

Central to the successful implementation of interventions is identifying key stakeholders and policy makers that are in positions of authority (whether that be moral, ethical, or managerial) and ensuring that they are committed to the success of the proposed intervention. We have arranged for a series of tiered workshops that will take place longitudinally within the communities of the watershed. Community leaders and policy makers will be included in these workshops, whose aim is to facilitate the transfer of knowledge from the research (biophysical, socio-economic) realm into the applied realm.

Outreach through personal communication and networking is ongoing in Kenya, and the host country PI and co-PIs will serve as science ambassadors to land managers, politicians, and policy makers. Long-term efforts are aimed at establishing professional relationships with policy makers beyond just those in the watershed, including at the National or International level, including NGO's and the Ministry of Water. In the past year, SUMAWA lead scientists (including Drs. Miller, Gichaba, and Shivoga) met with representatives of the locally active NGO's to discuss ways in which formalized relationships can be established. To date, Dr. Shivoga has been particularly active in meeting with interested parties, both at Egerton and in Nairobi. He has been invited to numerous sessions on sustainable development to provide his vision of watershed-based research, and these contacts will provide us with opening for discussion with these entities.

Developmental Impact

The goal statement of SUMAWA is "Multidisciplinary approach to develop and demonstrate improved and integrated sustainable management of watershed resources through stakeholder participation at the watershed scale". An associated development goal in the long-term is to develop tools and technologies designed to improve the health of threatened/degraded upland watershed systems in east Africa on a productive and sustainable basis. The primary biophysical research areas in the SUMAWA project are watershed hydrology and ecology, both of which are focused on quantifying environmental health and providing information to decision makers in order to maintain proper functioning condition. Over the next year the first steps will be taken towards developing a suite of environmental models that will be joined in a decision support system. This spatially explicit tool will be developed on the Njoro watershed to provide a template for integrated multiple objective decision making in which environmental concerns are weighed in consideration with human-related issues such as economics, human health, and off-site impacts.

Environmental impact and relevance . There are two identifiable indicators we are using in the pursuit of the overall objectives of SUMAWA: (1) Research goal: improve the understanding of biophysical and social dynamics governing watershed health in rural areas. (2) Development goal: improve the health of threatened/degraded upland watershed systems in east Africa on a productive and sustainable basis. The Njoro watershed system is fragile and has direct impacts on the ecological integrity of Lake Nakuru, a RAMSAR wetlands site of international importance. The upper reaches of the watershed extend into the forested reaches of the Mau escarpment. These forested areas, which have only recently lost their protected status, provided valuable stability to the ecological and watershed health of the region. The primary biophysical research areas in the SUMAWA project are watershed hydrology and ecology, both of which are focused on quantifying environmental health and providing information to decision makers in order to maintain proper

functioning condition. A suite of environmental models are being developed to better understand the environmental system as a whole. The Njoro watershed will provide a template for integrated multiple objective decision making in which environmental concerns are weighed in consideration with human-related issues such as economics, human health, and off-site impacts. Strategies for improved watershed condition serve as principal intervention options. Examples include agriculture conservation practices, especially on steep slopes, improved riparian condition for stream buffering, improved agricultural and grazing practices to reduce erosion and improve infiltration and groundwater recharge, and the application of agroforestry practices in sensitive areas.

Agricultural sustainability. One of the most significant concerns regarding the local and future condition of the Njoro watershed is the sustainability of agricultural practices. Anecdotal evidence suggests that even recent immigrants are concerned with soil sustainability and the future of agriculture in this region. A lack of economic and agricultural system diversity is present in the watershed, which increases the vulnerability of the residents to economic downturns associated with agriculture. A series of sustainable practices, best management practices, and potential alternatives to present cropping systems, are being investigated for potential use by the biophysical research team, and their likelihood of adoption and success evaluated by the applied economics and stakeholder teams. Examples include agroforestry, soil conservation practices, pond aquaculture, and increased variability in crops, including the reintroduction and harvest of indigenous plants.

Contributions to U.S. agriculture. The primary potential benefits to the US that will evolve from the SUMAWA project surround contributions in knowledge to U.S. agricultural systems. Management of landscapes, including rural areas in the United States has been shifting to a watershed-based approach. Land management agencies, including the US-EPA, NRCS, and BLM are moving resources and quantitative tools to the watershed scale in order to comply with both Federal regulations and to maintain a strong scientific footing in terms of understanding upstream-and downstream linkages in environmental health. It has long been recognized that water resources and their effective use and management for long-term sustainability are crucial to economic, human health, and environmental stability. This statement applies with equal validity to Kenya and the US. The problems facing residents of the Njoro watershed are undoubtedly more critical than those in developed nations such as the US, but parallels exist nonetheless. For example, the watershed is comprised of a mixture of stakeholders with a variety of complementary and competing interests, including agriculture, livestock grazing, business, residents, and the environment itself. Land cover is rapidly changing due to population pressures and policy decisions with resultant negative off-site impacts. Land managers and policy makers such as the BLM, State Departments of Environmental Quality, the USFS, and the National Park Service, are charged with managing resources with both a multiple use and sustainable yield mandate, often in locations similar to the Njoro where competing interests create difficulties for the land manager. Our framework for linking watershed studies with stakeholder engagement and outcome-based research may be of direct benefit and relevance to US land management agencies.

Contributions to host country. The Njoro watershed has been established as an experimental watershed with the addition of continuous monitoring stations for rainfall and runoff. These monitoring stations provide the means to use cutting-edge tools and models for scientific assessment and land management. There is a significant training component for Kenyan students and researchers and we recognize and maintain that successfully training students in integrated and sustainable research and decision-making will be beneficial to Kenya. An integrated decision support tool will be developed that will describe the processes governing watershed health and response to changes in land management and tenure. These tools will provide a scientific basis to interested parties, such as land managers, policy makers, and local residents interested in understanding their physical environment.

A series of interventions for the improvement of

economic stability, ecologic health and hydrologic resources are planned. These interventions include demonstration plots for pond aquaculture, agroforestry, alternative agricultural practices, and water distribution. It is anticipated that these interventions will have a localized beneficial impact. An outreach component will be implemented that links local landowners to the planned interventions so as to facilitate their adoption on other regions of the watershed that would have a larger-scale impact on watershed health. A school-based outreach and education component will introduce schoolchildren to land stewardship and environmental awareness.

Linkages and networking. A major advancement has been made in Kenya with respect to their Water Law and the management of watershed and large catchment systems: parastatal organizations have been established in all major catchments, including the Rift Valley. The SUMAWA team has enjoined the Rift Valley Water Resource Management Authority as a collaborative partner and drafted a memorandum of understanding to foster a long-term working relationship. This is a significant linkage insofar as the Authority is tasked with facilitating the establishment of watershed water users associations, which are locally-run bodies granted significant authority over their water and environmental planning. The SUMAWA team has built local community linkages through the process of stakeholder engagement (PRA) and will serve as a link between the Authority, researchers, and community leaders to aid in the creation of the watershed user's group with the goal of enhancing both local knowledge and management of their system for long-term sustainability under the newly emergent Kenya law.

Formal and informal methods are being pursued to enhance the profile of the team and to establish a network of communication within Kenya and in the international community. Host country PIs are working on establishing professional relationships with policy makers beyond those in the watershed, including those at the national or international level. For example, contacts have been made with representatives from the Rockefeller Foundation, Ministry of Water, Forest Department, and faculty from the University of Nairobi. The linkages with the Kenya Fisheries Department and Wildlife Service are being formalized through memoranda of understandings. SUMAWA lead scientists have met with representatives of the locally active NGO's Friends of the Mau Forest and the Kenya Forest Working Group to discuss ways in which formalized partnerships can be established. Dr. Shivoga has been particularly active in meeting with interested parties and enhancing cross-fertilization across Kenya. Members of the project have been invited to numerous sessions on sustainable development to provide the project vision of watershed-based research, and these contacts will provide us with opening for discussion with these entities.

Collaboration with international research centers (IARCS) and other CRSPs. The SUMAWA project was initially founded through a joint effort with the Aquaculture and Global Livestock CRSPs. The formal agreement with the Aquaculture CRSP has not been maintained, but members of the research team are active with the CRSP and we have incorporated pond aquaculture into the project as a potential intervention for enhanced income and a component of the sustainable development plan. A formal agreement with the Trade-off project led by John Antle and funded by the Soil CRSP is a direct outcome of the activities of the previous year. Future research directly builds on this relationship and project outcomes and activities are tied directly to the collaborative effort with this project.

Other Contributions

Support for free markets and broad-based economic growth (i.e., agribusiness and private enterprise). Research and development as approached by the SUMAWA team is directly targeted to account for the significant and cornerstone role agriculture plays in Kenya's prospects for long-term economic stability and sustainability. We are working with local agencies and community groups to create a comprehensive watershed plan in support of sustainable development. While the upper portion of the watershed lacks an agribusiness sector, the lower sections of the watershed are dominated by larger farms and trend towards a more urban setting; in the coming year we are targeting a better understanding

of and linkage with these groups. Private enterprise and access to markets are key components of our economic development and sustainability modeling efforts. It has been clearly recognized that access to free markets and a market-driven economy with effective techniques for responding to macro-scale economic forcing is extremely supportive of rural economic development and is a constraint in the Njoro watershed. Economic analyses and stakeholder engagement in the successful adoption of effective land management and farming practices are core constituents of our integrated modeling and decision support framework.

Contributions to and compliance with mission objectives. The SUMAWA project is directly in line with the primary USAID/Kenya natural resources program objective, which is to prevent unsustainable natural resource management and enhance conservation. Our focus influencing change through integrated science and stakeholder engagement is aligned with the Mission's approach. The Mission supports initiatives aimed at natural resource management with a focus on activities that are included in the SUMAWA scope of work, including watershed management, soil conservation, and agroforestry. The SUMAWA goals are also in line with the Mission's agriculture support objective, which promotes enhanced stakeholder dialogue and outreach for improved agricultural production.

Concern for individuals. This project is aimed primarily at improving watershed condition through stakeholder interactions. These stakeholders comprise multiple tiers of scale and influence, from land managers to business owners and the individual land owner. Interventions planned in this project are concerned with improving livelihoods and directly benefiting residents. The structure of the stakeholder engagement is specifically designed to facilitate and understand rationale behind decision making at the household scale.

Support for democracy. One of the essential components of a free and democratic society is an informed public. Individuals, communities and institutions should be aware of governance and decision making that impacts their lives. More importantly, people should be empowered with an opportunity to make themselves heard and participate in the decision-making process. This project contains these essential ingredients, as we are disseminating both research findings and policy acts that govern watershed dynamics directly to resident stakeholders. We have an education and outreach component operating in the local school system as a mechanism for increasing education, awareness, and participation.

Humanitarian assistance. Humanitarian assistance need not be solely restricted to immediate distribution of aid. In our case, we are providing assistance in the form of information exchange and suggestions for improving livelihoods. These suggestions are intended to enhance human health, economic condition, and reduce the exposure and risk of watershed residents to seasonal and political fluctuations. These approaches are designed to reduce long-term negative impacts and reduce rural poverty.

Leveraged Funds and Linked Projects

The value of leveraged funding for SUMAWA during 2005 was USD 11,604.

University of Wyoming Graduate School, Land cover classification and hydrologic modeling in the Njoro River watershed, Kenya, Scott N. Miller 2002-2005, $10,004.

University of Wyoming Renewable Resources Start-Up Allocation to Scott N. Miller, Land use patterns and population dynamics, Scott N. Miller, 2005 $1,000.

University of Wyoming NSF/EPSCoR Program - Undergraduate Scholarship, GIS Modeling: Investigating Population Dynamics and Changing Land Use Patterns in the River Njoro Watershed, Kenya, Scott N. Miller, 2004-2005, $600.

Training

Degree Training

Baldyga, Tracy. USA, University of Wyoming, Rangeland Ecology & Watershed Management, MS.

Bett, Eric. Kenyan, Moi University, Ecology, MS .

Boodleman, Colleen. USA, University of Wyoming, Agroecology, BS.

Chuchu, Tom. Kenyan, Egerton University, Ecology, MS.

Gichuru, Z.M. Kenyan, Egerton University, Watershed Hydrology, MS.

Huckett, Stephen. USA, Utah State University, Forest, Range, and Wildlife Sciences, PhD.

Kibichii, Samuel. Kenyan, Moi University, Ecology, MS.

Kuloba, Bernard, Kenyan, Egerton University, Environmental Science, MS.

Mainuri, Gichuru. Kenyan, Egerton University, Geography, MS.

Mjeri, Mary. Kenyan, Moi University, Ecology, MS.

Moturi, Wilkister. Kenyan, Egerton University, Environmental Science, PhD.

Muriithi, Anthony. Kenyan, Egerton University, Hydrology, MS.

Ndung'u, Charles, Kenyan. Egerton University, PRA – stakeholder, MS.

Oyoo, Malachi. Kenyan, Egerton University, Hydrology, MSc.

Sporkin-Morrison, Barnett, USA, University of Wyoming, Applied Economics, MS.

Thel, Laura. USA, University of Wyoming, Rangeland Ecology & Watershed Management, PhD.

Tiwari, Sangam. Indian, Univ. of California, Davis, Water Resource Engineering, PhD.

Krupnick, Tim. USA, Univ. of California, Davis, International Ag Development, MS.

Kanninen, Morgan. USA, Univ. of California, Davis, Civil & Environ. Engineer, BS.

Non-degree training

The Geospatial Revolution: GIS in the Rockies Annual Conference. Attended conference and delivered poster and presentation. September 21-22, 2004 in Denver, CO. Attended by 4 participants (1 male and 4 female).

African Water Laws: Plural Legislative Frameworks for Rural Water. Attended international workshop on water laws and delivered research paper accepted for publication in workshop proceedings. January 26-28, 2005 in Gautleng, South Africa. Facilitated by IWMI. Attended by 1 participant (1 female).

58th Annual Society of Range Management Conference. Attended conference and delivered poster and presentation in Fort Worth, TX. Attended by 1 participant (1 male).

International Grasslands Congress. Attended international congress and delivered poster presentation accepted for publication in proceedings. June 26 - July 1, 2005 in University College Dublin, Ireland. Attended by 8 participants (7 male and 1 female).

Pond Aquaculture Construction and Utilization. Technology transfer of pond aquaculture construction and management from SUMAWA scientists to community members. October 23-27, 2005 in Naishi, Kenya. Facilitated by Mucai Macharia. Attended by 8 participants (5 male and 3 female).

Training on field measurement techniques – hydrology. Train hydrologic technician and SUMAWA researchers on the use of data loggers for hydrologic monitoring. September 24, 2005 in Njoro, Kenya. Attended by 3 participants (3 male).

GIS / Database Training. Training on the use of ArcGIS for research, mapping and data management. September 2005 in Nakuru, Kenya. Facilitated by Oaskar Services ltd. Attended by 3 participants (3 male).

ASCE World Environmental & Water Resources Congress. Attend international congress and deliver presentation accepted for publication in proceedings. May 21-25, 2006 in Omaha, NE. Attended by 1 female participant.

Collaborating Personnel

Kenya

Chiuri, Lois. Egerton University, Gender Studies, PhD, Senior Lecturer /Dean.
Gitonga, Nancy. Kenya Fisheries Department, Aquaculture, MS, Director of Fisheries.
Inoti, Shadrack. Egerton University, Agroforestry, MS, Assistant Lecturer.
Kuloba, Bernard. Kenya Wildlife Service, Wildlife, BS, Biologist.
Lelo, Francis. Egerton University, Stakeholder Involvement, PhD, Senior Lecturer/Dean.
Liti, David. Moi University, Fisheries, MS, Lecturer.
Macharia, Simon. Kenya Fisheries Department, Aquaculture, BS, Biologist.
Maina-Gichaba, Charles. Egerton University, Geography, Hydrology, PhD, Senior Lecturer/ Head.
Muchiri, Mucai. Moi University, Aquatic Ecology, PhD, Senior Lecturer/Head.
Muhia, Njeri. Egerton University, Stakeholder Involvement, BA, Assistant Lecturer.
Ndettei, Robert. Kenya Wildlife Service, Wildlife Management, MS, Biologist.
Odanga, J.F.E., Moi University, Landscape Ecology, PhD, Lecturer.
Onyando, Jethro. Egerton University, Hydraulic Engineering, PhD, Senior Lecturer.
Ouma, Desterio. Egerton University, Economics, PhD, Senior Lecturer/Head.
Ouma, Shem. Egerton University, Economics, PhD, Lecturer.
Shivoga, William. Egerton University, Ecology, PhD, Senior Lecturer/Head.

United States

Jenkins, Marion. University of California, Water Resources/Public Health Engineering, PhD, Assistant Research Engineer.
Miller, Scott. Egerton University, Watershed Management / Hydrology, PhD, Assistant Professor.
Mooney, Sian. University of Wyoming, Agricultural and Applied Economics, PhD, Assistant Professor.

Collaborating Institutions

Kenya

Egerton University
Department of Environmental Science
P.O. Box 536
Njoro, Kenya
Tel: 254 – 37 – 62185,

Moi University
Department of Fisheries
P.O. Box 3900
Eldoret, Kenya
Tel: 254-321-63111

Kenya Fisheries Department
P.O. Box. 12912
Nakuru, Kenya
Tel. 037 41123/4, 0733 705634

Kenya Wildlife Service
Lake Nakuru National Park
Nakuru, Kenya.

United States

University of Wyoming
Department of Renewable Resources
P.O. Box 3354
Laramie, Wyoming, USA 82071-3354
Tele: 307-766-3114
FAX 307-766-6403

University of Wyoming
Department of Agricultural
and Applied Economics
P.O. Box 3354
Laramie, Wyoming, USA 82071
Tel: 307-766-2386
FAX 307-766-6403

University of California – Davis
Department of Civil
& Environmental Engineering
1 Shields Avenue
Davis, CA, USA, 95616
Tel: 530-752-0586

Utah State University
Department of Forest, Range,
and Wildlife Sciences
5230 Old Main Hill
Utah State University
Logan, UT 84322-52305

Montana State University
Dept. of Ag. Economics and Economics
P.O. Box 172920
Bozeman MT 59717-2920

Publications

Peer Review

Baldyga, T.J., S. N. Miller, K. L. Driese, and C. Maina-Gichaba, 2005. Using Landsat Imagery to Analyze Land Cover Change in the Njoro Watershed, Kenya. Proceedings of the XX International Grassland Congress. June 26 – July 1, 2005, Dublin, Ireland.

Chiuri, L.W., F. K. Lelo, M. W. Jenkins, and S.N. Miller, 2005. Development of a toolkit for participatory management of rural watersheds in Kenya. Proceedings of the XX International Grassland Congress. June 26 – July 1, 2005, Dublin, Ireland.

Onyando, J.O., M. O. Okelo, C. M. Gichaba, W. A. Shivoga, and S. N. Miller, 2005. Micro-field assessment of soil erosion and surface runoff using mini rainfall simulator in upper River Njoro watershed in Kenya. Proceedings of the XX International Grassland Congress. June 26 – July 1, 2005, Dublin, Ireland.

Shivoga, W.A., M. Muchiri, S. Kibichi, J. Odanga, S. N. Miller, T. J. Baldyga and C. M. Gichaba, 2005. Impact of land use on water quality in River Njoro Watershed, Kenya. Proceedings of the XX International Grassland Congress. June 26 – July 1, 2005, Dublin, Ireland.

Non Peer-Review

Baldyga, T.J., S. Mooney, S.N. Miller, D. Ouma, W.A. Shivoga. 2005. Institutions, Environment and Water Use: the River Njoro Watershed and Lake Nakuru. Accepted for Publication in: Proceedings of the 11th World Lakes Conference, Nairobi, Kenya, 30 October - 4 November, 2005.

Baldyga, T.J., S.N. Miller, K.L. Driese, R. Sivanpillai, C.M. Gichaba. 2005. Enhanced Land Cover Classification in a Tropical Kenya Landscape. Accepted for publication in: Proceedings of the Pecora 16: Global Priorities in Remote Sensing Conference, Sioux Falls, South Dakota, 23 - 27 October, 2005.

Jenkins, M.W., G.F. Marques, F.K. Lelo, and S.N. Miller, 2005. WEAP as a Participatory Tool for Shared Vision Planning in the River Njoro Watershed. Proceedings ASCE Water and Environmental Resources Congress, May 15-19, 2005, Anchorage, Alaska. ASCE, Arlington, VA.

Lelo, F.K., W. Chiuri, and M.W. Jenkins, 2005. Managing the River Njoro Watershed, Kenya: Conflicting Laws, Policies and Community Priorities. In African Water Laws: Plural Legislative Frameworks for Rural Water Management (Eds. B. van Koppen, J.A. Butterworth and I.J. Juma). Proceedings of a workshop held in Johannesburg, South Africa, 26-28 January 2005. International Water Management Institute, Pretoria, South Africa.

Abstracts and Presentations

Baldyga, T.J., S. N. Miller, K. L. Driese, and C. Maina-Gichaba, 2005. Using Landsat Imagery to Analyze Land Cover Change in the Njoro Watershed, Kenya. Poster presentation at the XX International

Grassland Congress. June 26 – July 1, 2005, Dublin, Ireland.

Boodleman, C., and S.N. Miller, 2004. GIS Modeling: Investigating Population Densities and Changing Land Use Patterns in the River Njoro Watershed Kenya. Poster presentation to McNair Scholars Annual Conference, October 2004, Fort Collins, CO.

Chiuri, L.W., F. K. Lelo, M. W. Jenkins, and S.N. Miller, 2005. Development of a toolkit for participatory management of rural watersheds in Kenya. Poster presentation at the XX International Grassland Congress. June 26 – July 1, 2005, Dublin, Ireland.

Jenkins, M.W., G.F. Marques, F.K. Lelo, and S.N. Miller, 2005. WEAP as a Participatory Tool for Shared Vision Planning in the River Njoro Watershed. Presented at ASCE Water and Environmental Resources Congress, May 15-19, 2005, Anchorage, Alaska. ASCE, Arlington, VA.

Lelo, F.K., W. Chiuri, and M.W. Jenkins, 2005. Managing the River Njoro Watershed, Kenya: Conflicting Laws, Policies and Community Priorities. Presentation given to "Plural Legislative Frameworks for Rural Water Management" a workshop held in Johannesburg, South Africa, 26-28 January 2005.

Miller, S.N., 2005. Controlled chaos: integrating research and people in a multidisciplinary research framework. Invited speaker to Research Across Disciplines Seminar Series, February 25, 2005, Laramie, WY.

Miller, S.N., 2004. Sustainable Management of a Rapidly Changing Kenya Watershed. Invited talk to International Programs Board Meeting, University of Wyoming.

Miller, S.N., H.R. Griscom, T. Gyedu-Ababio, N. Korfanta, and W.A. Shivoga, 2005. A multidisciplinary research and outreach framework for the sustainable management of watersheds. Abstract and oral presentation at the 3rd Annual Kruger National Park Science Networking Meeting, April 4-8, 2005, Phalaborwa, South Africa.

Miller, S.N., W.A. Shivoga, C. Maina-Gichaba, D. Ouma, F. Lelo, M. Muchiri, and L. Chiuri, 2005. SUMAWA: Sustainable Management of Watersheds - River Njoro Project. Oral presentation at Global Livestock CRSP Meeting. June 25, 2005, Dublin, Ireland.

Onyando, J.O., M. O. Okelo, C. M. Gichaba, W. A. Shivoga, and S. N. Miller, 2005. Micro-field assessment of soil erosion and surface runoff using mini rainfall simulator in upper River Njoro watershed in Kenya. Poster presentation at the XX International Grassland Congress. June 26 – July 1, 2005, Dublin, Ireland.

Shivoga, W.A., M. Muchiri, S. Kibichi, J. Odanga, S. N. Miller, T. J. Baldyga and C. M. Gichaba, 2005. Impact of land use on water quality in River Njoro Watershed, Kenya. Poster presentation at the XX International Grassland Congress. June 26 – July 1, 2005, Dublin, Ireland.

Thel, L., S. Mooney, D. Ouma, and S.N. Miller, 2005. Applying integrated modeling of economics and natural resources to a Kenyan watershed. Poster presentation to the Annual University of Wyoming Graduate School Symposium, April 20, 2005.

Lead Principal Investigator

Scott Miller, Assistant Professor, University of Wyoming, Department of Renewable Resources, P.O. Box 3354, Laramie, Wyoming, USA 82071-3354, Tele: 307-766-3114, FAX 307-766-6403. Email: snmiller@uwyo.edu.

Beef as a Source of Vitamin B-12, Iron and Zinc to Improve Development of Infants Fed Low Amounts of Animal Products

Narrative Summary

In a low-income area of Guatemala City we reported previously that almost two-thirds of infants aged 7 to 12 months had plasma vitamin B-12 concentrations that indicated depletion or deficiency of the vitamin. The only dietary source of this vitamin is animal source foods (ASF) and diets of mothers and young children in these communities, as in most poor regions of the world, are low in ASF and consequently vitamin B-12. Because it is known that severe vitamin B-12 deficiency has adverse, possibly permanent effects on infant and child development, this study was designed to test associations between B-12 status and indicators of child health and function, and the effect of food-based interventions on B-12 status and child growth, cognitive and motor development, activity and behavior. In addition, the effect of beef supplementation on iron and zinc status will be determined. Subjects were 304 Guatemalan children, aged 1 year at enrollment, and their mothers. 80% of the infants were still consuming some breast milk. The three equi-caloric dietary interventions, provided daily under supervision for 9 months, were: a beef meal, a control meal (commercial turkey-rice and fruit), and the control meal + added vitamin B-12 equivalent to the daily recommended intake. Indicators of child function and development were measured throughout the intervention and outcomes in the beef and B-12 supplemented groups will be compared to those in the control group. The field phase of the study ended in August 2005 and laboratory and statistical analyses are in progress. Analysis of baseline data on the 304 children confirms the high prevalence of vitamin B-12 depletion in the infants (30% deficient and 20% marginal status) and their mothers (36% deficient and 33% marginal status). Low plasma B-12 concentrations in infants were predicted by lower maternal plasma B-12, less vitamin B-12 intake from complementary foods (primarily powdered cow's milk), more dependence on breast feeding, and smaller household size. Infants with plasma vitamin B-12 levels that indicated deficiency had poorer motor skills related to secure walking, and those consuming less than the average vitamin B-12 intake had a lower mental score on the Bayley assessment exam than those consuming above the average amount. Mothers with deficient plasma vitamin B-12 concentrations had a 60% greater risk of depressive symptoms, after controlling for socioeconomic and other variables. These preliminary analyses of baseline data confirm the high prevalence of vitamin B-12 deficiency in mothers and infants in this population, and suggest that maternal depletion is one cause of the infant depletion. Deficient plasma B-12 levels predicted poorer motor and mental development of the children, and greater risk of depressive symptoms in the mothers. Analysis of the effects of the beef and vitamin B-12 interventions on child development is in progress.

Research

Problem Statement and Approach. The high global prevalence of vitamin B-12 deficiency has been recognized relatively recently. For example the World Health Organization held a Consultation on Vitamin B-12 in October, 2005, the first for more than 40 years. A review by the Principal Investigator of this project concluded that about 40% of individuals studied in Latin America had deficient or marginal plasma vitamin B-12 concentrations. In our previous research in Guatemala City we observed that plasma vitamin B-12 was deficient or marginal in about one third of school children, and 30% of lactating women at three months postpartum and 12% of their breastfeeding infants, and two thirds

of infants aged 7 to 12 months. The main cause of the vitamin B-12 deficiency appears to be a low intake of animal products, as B-12 is only found in animal source foods unless the foods are fortified with the vitamin.

This research is designed to answer several important questions based on these observations. The most important is whether the low plasma vitamin B-12 levels in infants are associated with adverse effects on their mental and motor development, activity and behavior, and on maternal depressive symptoms. Severe deficiency has been shown to have these effects in other studies. Second, we propose to determine whether meat or vitamin B-12 supplementation of young children with a high prevalence of vitamin B-12 deficiency improves their nutritional status, growth and development. Third, predictors of infant vitamin B-12 deficiency at baseline will be investigated, including their diet, maternal B-12 status, and breast milk B-12 concentrations.

Specifically, the research will evaluate the effects of supplementation with beef, or vitamin B-12, on the cognitive and motor development, activity, temperament, growth and morbidity of these young children. The three randomized intervention groups (recruitment goal 80 children per group, completion goal 60 per group), providing a similar amount of calories, are: 1) a beef supplement; 2) a low meat control meal (commercial turkey and rice dinner and fruit infant foods); and 3) the same control meal fortified with vitamin B-12.

The relevance to global agriculture and development is that a low intake of animal products may cause vitamin B-12 deficiency and have permanent adverse effects on child development and human capital formation. Documentation of such adverse effects caused by vitamin B-12 deficiency could increase attention to the need for increased animal source food intake and production in low income populations of developing countries, and the importance of animal source foods for normal human development.

Progress. After an initial pilot testing phase, the intervention started in October 2003 with funding from the National Cattlemen's Beef Association. Funding from the GL-CRSP was added starting in October 2004. From October 2003 to December 2004, children were enrolled into the three randomized groups fed the supplemental foods daily, under observation. At 0, 3, 6 and 9 months of intervention, data were collected on usual diet, anthropometry, cognition and development, behavior, activity, and morbidity. Maternal measures at baseline included plasma B-12, a breast milk sample for B-12 analysis, anthropometry, diet, socioeconomic and other household data, and reported depressive symptoms. Blood samples to assess nutritional status were collected at baseline and after the nine months of supplementation. The intended number of children completed the study (241, compared to the desired final sample size of 180). All fieldwork was completed exactly on schedule, by September 2005. Some baseline analyses have been completed, and final sample and data analysis and publication are in progress. There were no substantial modifications from the original protocol or work plan, and no changes from the planned schedule of work.

Table 1. Reasons for withdrawal from the study.

Reason	N	%
Moved to other community	28	47
Parents did not want to continue	13	22
Lack of interest/time	10	17
Child did not like the supplement	6	10
Severe disease/death*	2	3
Lack of trust	1	1
TOTAL	60	100

Preliminary results. Some analyses have been conducted on the baseline interviews and samples taken from 304 infants and their mothers, when infants were 12 months of age. Eighty percent of the infants were partially breastfed, 29.8% had marginal plasma vitamin B-12 concentrations (200-300 pg/mL) and 19.5% had deficiency (<200 pg/mL). Of the mothers, 37.5% had marginal vitamin B-12 status and 32.5% were deficient. Anemia was present in 14.5% of infants and 9.8% of mothers, and 39.4% of infants were iron deficient. Lower infant plasma vitamin B-12 concentrations were predicted by lower

maternal plasma vitamin B-12, higher B-12 intake from complementary foods (almost all of which came from cow's milk), higher frequency of breastfeeding (because the breast milk contains much less vitamin B-12 than cow's milk), and smaller household size (P<0.0001).

In the mothers, 43% had a high depressive symptoms score, which was predicted by lower plasma vitamin B-12 concentrations, a lower platelet count, a higher body mass index, and having more children (all P<0.05). The relative risk for having more depressive symptoms was 1.6 for women with deficient vs. adequate plasma vitamin B-12 concentrations (P<0.005).

The baseline analyses also suggest that vitamin B-12 deficiency is adversely affecting infant development. Infants with deficient plasma vitamin B-12 concentrations had poorer performance of motor skills related to secure walking, compared to adequate infants (P<0.005), and those consuming <1.44 µg/d of vitamin B-12 from complementary foods had a lower mean Mental Development Index score than infants consuming >1.44 µg/d (P<0.05).

In summary, as expected the infants and their mothers have a very high prevalence of vitamin B-12 deficiency. This is accompanied by a higher rate of maternal depressive symptoms, and poorer walking skills and mental development in the infants. The causal role of vitamin B-12 deficiency in these adverse functional outcomes will be evaluated during the coming year using the data from the longitudinal beef or vitamin B-12 supplementation study.

Gender

A total of 158 boys and 146 girls were enrolled into the study, and gender differences in outcomes at baseline and post-intervention will be evaluated. Differences in initial B-12 status and other measures will be examined by gender at baseline, as will responses to intervention. No gender differences have been observed in B-12 status in our previous studies.

The mothers of all the 304 infants also participated in this research. This research has demonstrated that 70% of the mothers are vitamin B-12 depleted or deficient and this is associated with a higher risk of deficiency in their infants at 12 months postpartum (and presumably much earlier during the first year of life), and with higher risk of maternal depressive symptoms. We also plan to analyze the breast milk vitamin B-12 concentration of these women and baseline to confirm that maternal deficiency vitamin leads to lower secretion of the vitamin in breast milk and subsequently greater risk of infant depletion. The potential implications are that these women need to learn the importance of increased animal source food intake during pregnancy and lactation, they may also need supplementation with the vitamin, and a national B-12 fortification program may need to be considered.

A group of 12 women from the community were trained as Community Motivators for this project. They were responsible for contacting mothers, setting up clinic visits, distributing and observing the consumption of the food supplements, collecting morbidity data, and alerting the project supervisory personnel about medical or other problems. This training has provided these women with qualifications that will improve their future employment opportunities and their knowledge of the importance of nutrition for child development.

Other training included two licensed Guatemalan psychologists who were instructed by the lead Guatemalan psychologist and Dr. Maureen Black on the application of child development tests. The Field Director, a female Guatemalan physician, has been trained in data entry and analysis.

Policy

This research makes several important contributions to our knowledge of nutritional status problems of mothers and infants in areas of the world where the consumption of animal source foods is low. Inadequate intake of these foods causes maternal depletion of vitamin B-12, which during pregnancy results in low B-12 stores in the infant at birth, and inadequate amounts of the vitamin in breast milk.

Several changes in policy need to be made as a

result of the baseline analyses completed to date. The first is to improve the intake of animal source foods by mothers and young children. In these peri-urban communities, where a wide variety of cheaper meats is available, the most feasible strategy is probably education of the mother and the household about the importance of consumption of these foods (which are also the main source of other nutrients such as absorbable iron and zinc) for healthy pregnancy outcome and child development. This strategy was successful for improving animal source food consumption in Lima, Peru. Encouragement to include dried or whole milk intake of mothers, infants and children would also increase their B-12 intake substantially. Another potential strategy, which is under discussion, is the addition of vitamin B-12 as a fortificant to wheat or maize flour. Wheat flour is currently fortified with folic acid but not vitamin B-12 in Guatemala and many countries in the world.

Activities are already underway to ensure that policy-makers are involved in evaluating the results of the study and aware of potential strategies to improve the situation.

Preliminary results on the vitamin B-12 deficiency problem in Guatemala and other Latin American countries were shared with the Nutrition office at the Pan American Health Organization (PAHO) in Washington D.C. PAHO is the regional office of the World Health Organization responsible for Latin America. This led to a Consultation on Folate and Vitamin B-12 Deficiency in the Americas to recommend the addition of vitamin B-12 as well as folic acid as fortificants for flour in Central and South America (see Allen, L., Folate and B-12 status in the Americas, Nutr. Rev. June 2004, and Flour Fortification with Iron, Folic Acid and Vitamin B-12, PAHO, Washington D.C., 2004).

Results of the baseline analyses were reported briefly in an invited lecture by Dr. Lindsay Allen on dietary problems of preschoolers, at the International Congress of Nutrition in Durban, South Africa, September 2005.

Dr. Allen was one of the organizers of a WHO Consultation on Folate and Vitamin B-12, held in Geneva, October 2005. She worked with WHO in the development of a global data base of the prevalence of vitamin B-12 deficiency which revealed that this is a widespread problem, and presented a paper on the evidence that a lack of animal source foods was the main cause of vitamin B-12 deficiency in developing countries.

Dr. Allen was invited to present a lecture on the Animal Source Foods as a Source of Micronutrients in Developing Countries, at the Board for International Food and Agricultural Development meeting, held in Des Moines, Iowa, October 2005, in conjunction with the World Food Prize ceremony.

Once the results of the food-based intervention study are completed in 2006, additional activities will include the following.

The results and their implications will be shared at a scientific meeting at INCAP, Guatemala. INCAP serves the seven countries of Central America and a meeting will be selected where their representatives are present.

Results will be reported at the Society for International Nutrition Research annual meeting, the congress of the Latin American Nutrition Society, and in multiple publications.

Outreach

The primary outreach target will be women and children in regions of the world where the intake of animal source foods, and subsequently of vitamin B-12, is low. The mothers and children in this study are broadly representative of the high proportion of people in low income countries who consume inadequate amounts of animal source foods. We have learned from this Guatemalan study that consumption of cow's milk, rich in vitamin B-12, improves the vitamin B-12 status of these young children so it should be encouraged as a complementary food after the recommended six-month initial period of exclusive breast feeding. It is also apparent that the nutritional status of these women is inadequate to support the nutrient requirements and normal development of their infants. In the GL-CRSP funded Child Nutrition Project in Kenya, we demonstrated that inclusion of small amounts of meat or milk in snacks provided at school virtually eliminated the high prevalence of severe vitamin B-12 deficiency. This is a feasible

strategy in many situations. Additional extension approaches include the need for nutrition education of women and households on the importance of animal source foods; and increased emphasis on household animal source food production and preservation in agricultural development and training programs.

Dr. Ramirez is responsible for research on food security at INCAP and will follow up appropriately with the agricultural community through INCAP on the need for increasing animal source food intake, once the results of the study are known.

Developmental Impact

Environmental impact and relevance. There is no direct environmental impact of this project. In the longer-term, it must be recognized that sufficient production and consumption of animal source foods is required for optimal human nutritional status and capital formation, and that this need should not be ignored even where there are environmental constraints.

Agricultural sustainability. This research will make it more evident that the concept of agricultural sustainability must include production and consumption of animal source foods, because of their demonstrated importance in improving dietary quality (micronutrient content of the diet). In low income countries, unless staple crops can be fortified with micronutrients such as vitamin B-12, and fortified foods are consumed in reasonable amounts by subsistence households, animal source foods are the only dietary source of some micronutrients such as vitamin B-12, and the major source of iron, zinc and other micronutrients. It is becoming increasingly accepted that it is infeasible to provide vitamin-mineral supplements for all populations in developing countries who need them; at present these are given only to some pregnant women and a few young children. Thus the definition of agricultural sustainability must include a minimum level of animal source food production and consumption by the population.

Contributions to U.S. agriculture. The nutritional risks associated with avoidance of animal source foods, and especially meat, are not adequately appreciated in the U.S. or the world in general. For example, the practice of restricting the meat intake of children in the United States has become more common because some parents believe that "red meat" has adverse effects on health. In a recent study at UC Davis, for example, wealthier parents fed far less red meat to their children than did those in lower socioeconomic groups; 91% of lower income children and 100% of higher income children failed to meet the minimum number of meat servings. In an analysis of data from the National Health and Nutrition Education Survey (NHANES III), we found that plasma vitamin B-12 levels were significantly lower in those with lower intakes of meat. Many studies are revealing that lacto-ovo vegetarians or those who consume low amounts of meat, in industrialized countries have poor vitamin B-12 status, so meat needs to be consumed to ensure vitamin B-12 intake is adequate. In general, the study will reveal the importance of meat consumption for the lactating mother, and the normal development and nutritional status of young children.

Contributions to host country. INCAP is one of the premier nutrition institutions in Latin America, and for more than 50 years has been dedicated to research and its application to prevent and treat malnutrition. INCAP has collaborated with UC Davis in several previous studies that confirm the high prevalence of vitamin B-12 deficiency in lactating women, their infants, preschoolers and schoolers in peri-urban Guatemala City. The proposed research will enable INCAP to understand the prevalence and etiology of vitamin B-12 deficiency during the critical first year of life, as well as the adverse consequences of this deficiency, and eventually the need and application of strategies to prevent this wide-spread problem. This project has also increased the expertise of investigators at INCAP and enabled an important exchange with senior researchers who are working on this topic. The collaborative research has provided training and research skills with new methods of assessment, laboratory techniques, community-based research and especially in measures of child development. This is a critical area of interest to INCAP. The project has contributed to INCAP's technical capacity and involvement in the area of

micronutrients and will result in peer-reviewed and locally/regionally relevant publications. INCAP will transfer the information learned to its member states, increase awareness about the importance of vitamin B-12 deficiency, and guide related policy decisions such as the need to support animal source production and consumption, to fortify maize and wheat flour or other foods with vitamin B-12, and/or provide vitamin B-12 containing micronutrient supplements to infants, pregnant and lactating women. Moreover, the research is highly relevant to the current incentive supported by the GL-CRSP to increase awareness of the nutritional importance of consuming animal source foods, and will inform development specialists and nutritionists in the region (and world) about their special importance for child development.

Linkages and networking. Dr. Ramirez is closely connected with Central America's focus on sustainable agriculture and will share the results of this research with the member countries. Dr. Allen will continue to work closely with the World Health Organization in the publication of the Consultation on Folate and Vitamin B-12, where the baseline results of this study were presented. Dr. Black will share the child development results at meetings concerned with child health. The team has been partially supported by the National Cattlemen's Beef Association which will publicize the results of this research. Preliminary results on the importance of animal source foods were presented to the Board on International Food and Agricultural Development, and at the American Association for the Advancement of Science, by the PI in 2005. The PI meets with the GL-CRSP investigators who will be updated on the results of this research, including those in projects studying constraints to animal source food consumption.

Collaboration with international research centers (IARCS) and other CRSPs. Drs. Allen and Graham have worked previously with the GL-CRSP's Child Nutrition Program in Kenya, which included beef and milk supplementation of schoolers. Dr. Allen's group demonstrated the beneficial effects of the animal source food intervention on vitamin B-12 status of the Kenyan children. More recently Drs. Allen and Graham received GL-CRSP funding to analyze the contribution of animal source foods to the dietary intake of the Kenyan children, in collaboration with Dr. Marie Ruel of the International Food Policy Research Institute (IFPRI, a member of the CGIAR). They compared dietary diversity and animal source food intake as indicators of dietary adequacy and determined that dietary diversity was the best indicator of dietary quality when animal source food intake was very low, and that above a minimum level of intake, animal source foods significantly improve dietary quality.

Other Contributions

Support for free markets and broad-based economic growth. This research will demonstrate the importance of animal source foods for adequate human nutrition, normal child development and human capital formation, thereby enabling broad-based economic growth. It will provide impetus to activities such as: nutrition education concerning the need to consume animal source foods; promotion of initiatives to increase animal source food production and consumption at the household, regional and national level; and innovative ways to preserve animal source foods and to feed them to young children.

Contributions to and compliance with mission objectives. Achievement of food security and consumption of a nutritionally adequate diet is an important objective of the GL-CRSP, and has long been an objective of USAID. This research will encourage renewed emphasis on the importance of animal source foods in agricultural production, and the role that animal production must play to enable normal human development and capital formation.

Concern for individuals. This project made a substantial contribution to the women and children who participated in this research. Mothers and infants who were severely vitamin B-12 deficient at baseline were all treated with injections of the vitamin. Individuals with illness, and children diagnosed with severe developmental delays, were referred for medical attention and appropriate care. One meal per day was provided to each of the children during the 9 months they participated in the study. The mothers, their households, community motivators and project staff all gained an increased

awareness of the importance of nutrition for child development.

Support for democracy. This research can demonstrate the fact that population groups, including those with limited resources, can improve their nutritional status and human capital formation through adequate consumption of animal source foods. Increased attention to this issue will reduce risk of functional impairments such as poor child development and increased risk of maternal depression, creating individual opportunities for achievement and more stable and democratic societies.

Humanitarian assistance. If households cannot obtain access to a food supply that provides sufficient nutrients to support their needs, this engenders the need for short term humanitarian support such as feeding programs, and remedial treatment with vitamin mineral supplements. In contrast, making animal source food production and consumption a focus of development programs will increase sustainability of a nutritionally adequate food supply for the population.

Leveraged Funds and Linked Projects

This project has been able to leverage personnel funds and with support in-kind of two co-investigators to ensure that the study is administered and progresses toward successful completion. There have been no linkages to other grants/projects used for the conduct of this study.

USDA-Agricultural Research Service ($14,250 per year; salary). Dr. Lindsay Allen is the Principal Investigator and the primary person responsible for all aspects of the study during FY04-05. She provides 10% of her time to this project.

USDA-Agricultural Research Service ($9,942 per year; salary). Dr. Joanne Graham is a Postdoc supervising Dr. Allen's laboratory and is the main day-to-day UC Davis communicator with the field and with INCAP. She provided 20% of her time to this project. Duties included obtaining lab and other supplies, ensuring timely shipment of supplies including food, developing protocols for lab assays at INCAP and UCD and sample collection at INCAP, and some data analysis.

Support In-kind - Dr. Maureen Black (consultant) is a trained child development expert/psychologist who has years of experience in assessing the impact of nutrient intervention studies on child development in developing countries, and in assessing mother-child interactions. She was responsible for training and development in all areas of child development in this study.

Support In-kind - Dr. Margaret Bentley (consultant) is a Medical/Nutritional Anthropologist who has international experience in the assessment of food intake and feeding practices of infants and children; assessment of child activity (including a zinc intervention trial with INCAP in Guatemala which showed positive effects on activity); and ethnographic techniques that will enable us to understand the mother's perception of their child's health and development relevant to the cultural norm, and issues such as how to motivate the parents to adhere to the intervention. She provided guidance in the training of staff for the assessments of child activity, feeding and health and designed the pilot trials of infant acceptance of the supplementary foods.

Training

Degree

Katherine Jones, PhD, 2005, Nutrition, University of California, Davis. Completed.

Kathleen Deegan, PhD, 2007, Nutrition, University of California, Davis. In-progress.

Non-Degree

Dr. Manuel Ramirez-Zea attended a two week training session with the project statistician at the University of California, Davis in the Fall, 2004, to learn and coordinate data cleaning methods, and data analysis procedures with the Davis team. Partial support was provided by Fogarty.

Collaborating Personnel

United States

Allen, Lindsay. Lead Principal Investigator, USDA - Western Hum Nutr Res Ctr and University of California, Davis.
Bentley, Margaret (Peggy). University of North Carolina.
Black, Maureen. University of Maryland.
Graham, Joanne. Postdoc, USDA - Western Hum Nutr Res Ctr.
Jones, Katherine. Graduate Student, UC Davis.

Guatemala

Ramirez, Manuel. Project Director, INCAP.
Torun, Benjamin. Consultant, INCAP.
Zuleta, Clara. Project Supervisor, INCAP.
Mejia, Rosa Mery. Psychologist, INCAP.
Navas, Lilian. Field Supervisor, INCAP.
Ramos, Luisa. Secretary, INCAP.
Salazar, Irma. Data Entry, INCAP.
Muz, Ana. Psychology Student, INCAP.
Hernandez, Lorena. Psychology Student, INCAP.
de Juarez, Thelma. Interviewer, INCAP.
de Maldonado, Tania. Interviewer, INCAP.
Castro, Alvaro. Driver, INCAP.

Collaborating Institutions

USDA, ARS Western Human Nutrition Research Center and Dept. of Nutritional Biology
University of California, Davis
Davis, CA 95616
Phone: (530) 752 5269
Fax: (530) 752 5271

Instituto de Nutricion de Centro America y Panama (INCAP)
Calzada Roosevelt, Zona 11
Apartado Postal 1188, Guatemala City
Guatemala
Phone: (502) 2471 9913
Fax: (502) 2473 6529

Publications

Jones, K.M. (2005) Vitamin B-12 Deficiency in Guatemalan Mother and Infants: Prevalence, Predictors, and Associations with Maternal Depression and Infant Development. Ph.D. thesis, University of California, Davis.

Abstracts and Presentations

Jones, K.M., Black, M.M., Mejia, R.M., Ramirez-Zea, M., Zuleta, C., Allen, L.H. Cognitive function, motor skills, and behavior of Guatemalan infants with highly prevalent deficient and marginal plasma vitamin B-12 concentrations. 2005. Submitted for presentation at Experimental Biology 2006.

Lead Principal Investigator

Lindsay Allen, Emeritus Professor, Department of Nutrition, and Center Director, USDA - Western Human Nutrition Research Center. University of California, Davis. Davis, CA 95616. Tel: (530) 752-5920 or (530) 752-5268. Email: lhallen@ucdavis.edu.

GOBI FORAGE – Forage Monitoring Technology to Improve Risk Management by Herders in the Gobi Region of Mongolia

Narrative Summary

The GOBI FORAGE project represents an expansion of the existing LINKS/GLCRSP project which is applying forage and animal monitoring technology developed in the LEWS phase of the program to pastoral communities in another country: Mongolia. The project addresses rural business development by adapting proven LEWS/GLCRSP monitoring technologies so that they can be used by Mongolia's livestock producers. These technologies will provide timely information on forage conditions to increase lead time for making risk mitigation decisions by herder groups and policy makers. Nutritional profiling to assess and manage livestock performance will be integrated with the forage monitoring technology via other funding sources (Mercy Corp-USDA) to enable herders to make business decisions that enhance profitability within an array of livestock enterprises. Formation of herder alliances for marketing will be pursued in collaboration with Mercy Corp. The USAID Mission supported GOBI II initiative run by Mercy Corp will form the umbrella under which this project will function.

Research

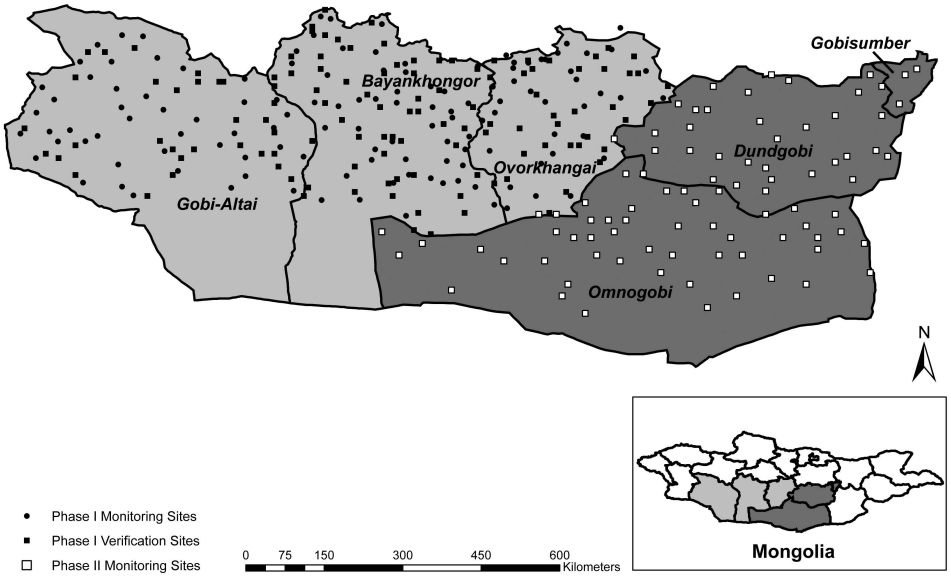
Activity One: Infusion of Forage Monitoring Technology

Problem Statement and Approach. Drought and winter disasters represent a major risk confronting herders in Mongolia. During the period from 1999 to 2001, as much as 35% of the Nation's livestock have been lost to these two disaster events. To help address these challenges to livestock production in Mongolia, a livestock early warning system is being pursued. Our objective is to develop a forage monitoring system that provides near-real time spatial and temporal assessment of current and forecasted forage conditions for Mongolia livestock producers.

Progress. After completion of training in use of the PHYGROW and LEWS technology, two trips were conducted, one in June and the other in August, where the USA team and Mongolian team conducted field verification measurements of vegetation and established a series of new monitoring sites in the Dundgobi, Gobisumber, Omnogobi aimags with new verification sites added in. To date 127 monitoring sites have been established in the Gobi Altai, Banyonhongor and Uvurhangai aimags along with an additional 120 randomly selected verification sites (Phase 1 sites, Figure 1). A subset of the verification sites were monitored during this fiscal year. The remaining sites will be monitored during the next fiscal year. In the Dundgobi, Gobisumber, Omnogobi aimags, 90 sites have been established (Phase 2 sites, Figure 1). All of these sites were characterized during June to September 2005.

A web site has been established at http://glews.tamu.edu/mongolia that provides access to the model output for those sites that are fully functional and tested. Several new vegetation condition and forage condition indices have been tested as well as linkage to the CMORPH rainfall data from NOAA FEWS NET. The vegetation condition indices have been tested include the Vegetation Condition Index (VCI) and the Forage Condition Index (FCI). The VCI is an index derived entirely from Normalized Difference Vegetation Index (NDVI) data. The current NDVI is scaled according to the historical minimum and maximum for a pixel and the index reflects where the current pixel falls along this scale. Current pixels that are scaled very close to the minimum are defined as severe drought. The FCI

Figure 1. Location of the monitoring sites in the Phase I and Phase II aimags in the Gobi Region of Mongolia. Phase I indicates sites initially monitored in fiscal year 2004 and Phase II sites are sites monitored in fiscal year 2005.



is calculated using the same logic as the VCI and values of livestock forage that fall close the historical minimum are considered severe drought.

Forage mapping using geostatistical methods has been conducted for the Phase 1 sites. Initial mapping using cokriging was not successful due to problems with low forage conditions during the early part of the growing season, so alternative mapping techniques were examined. The most promising method was a pixel based regression technique built from the time series of NDVI and forage for pixels containing the monitoring sites. As the growing season progressed, statistics for cokriging improved and this method was used. However, another problem was identified in that the CMORPH rainfall data appeared to be over predicting rainfall in portions of the region, especially in the higher elevation areas. We are currently working with the Mongolia Institute of Meteorology and Hydrology and NOAA to better understand this issue and to resolve it using bias correction techniques.

Activity Two: Infusion of the NIRS/NUTBAL Nutritional Management System

Problem Statement and Approach. In addition to drought and winter disasters, herders in Mongolia have no information on nutritional deficits or opportunities for inputs of supplements to help them transfer from a subsistence to entrepreneurial system of production. The major limitation is the lack of monitoring technology for them to make this transition to understand how to best graze forage resources and input strategic nutrients. Our specific objective for this activity is to develop a nutritional monitoring system for sheep, goats, cattle, yak and horses that provides assessment of nutritional balance, changes in body conditions and optimal fodder interventions for Mongolia livestock producers.

Progress. This activity was funded by monies provided to Mercy Corps via USDA Wheat Monetization funds. Our proposed study area is still under advisement from Mercy Corps and USDA, but discussions have focused on working with a private NGO on intensive dairies north of Ulaanbaatar and with cattle, sheep, goats, horses and yak in the region north of the aimags associated with the GOBI forage region. We plan to have some overlap with the GOBI Forage regions.

We have initiated testing a portable NIRS spectrophotometer from Ocean Optics both laboratory and filed settings, and a potentially

portable system from Perten in the laboratory. Mercy Corps has agreed to purchase a second Ocean Optics NIRS systems to help us cover more geography with the portable NIRS lab concept. Sheep calibration equations were successfully re-created on both the Ocean Optics (CP: RSQ = 0.97, SEP 1.20, DOM: 0.92, 1.25 respectively) and Perten (CP: RSQ = 0.97, SEP 0.77, DOM: 0.87, 1.24 respectively) instruments.

The NUTBAL PRO software package's multiple language database has been provided to the Mongolian team and is translated so that the package can be used in the Mongolian language. The material has been incorporated into an updated version of the metric NUTBAL PRO software that was successfully tested in the LEWS/GLCRSP project in east Africa.

Activity Three: Forage Monitoring Information Delivery and Outreach

Problem Statement and Approach. Develop an information and communication infrastructure and analysis delivery system to provide herders with information on current and forecasted forage conditions that will assist them to make timely and specific management decisions in the Gobi Initiative Project region of Mongolia.

Progress. We initiated talks with Mercy Corps Rural Business News personnel and mapped out how we are going to deliver the GOBI forage information to the herder groups. A DVD with 3, 5-minute segments on the nature of disasters facing Mongolian herders, the GOBI forage technology package and herder alliance has been designed and filming started. We were able to work with the Mercy Corps information group to prepare the design for distribution and narration of the DVD that will be in English and Mongolian. Mercy Corps is primarily responsible for this activity with GOBI Forage assisting in data flow and data presentation issues.

We also met with personnel in the Mercy Corps Arvaiheer office in the Overhungai aimag. These personnel will be conducting training and outreach activities for Gobi Forage products within this aimag during the coming fiscal year. A training program was outlined and a plan of implementation was discussed. Design of maps and situation reports was discussed so that templates could be built for use by the aimag offices in disseminating the information to local herders.

Activity Four: Nutritional Monitoring Information Delivery and Outreach

Problem Statement and Approach. Develop an information and communication infrastructure and analysis delivery system to provide herders with information on nutritional status of livestock and potential interventions to meet production goals.

Progress. The outreach program was designed to allow integration with Mercy Corps and their work in some of the more productive livestock regions of Mongolia. Dr. Udval Gombosuren, was provided training in outreach issues with GANLAB during her training at Texas A&M University. She translated several of the information sheets that were felt useful for communicating the NIRS/NUTBAL system to herders.

Activity Five: Linking the GLCRSP Technology to the Herder Associations

Problem Statement and Approach. Linking the GLCRSP technology to the herder associations, which are seen as viable structures, to insure institutionalization of both the forage and nutritional monitoring technology in Mongolia after the end of the Project.

Progress. A 15-minute DVD video has been designed, filming completed and first draft finished which incorporates three topics covering the nature of disasters facing Mongolian herders, the GOBI forage NIRS and early warning technology and the formation of herder marketing alliances. We were able to acquire the services of Dr. Dennis Sheehy who worked with Mercy Corp to design the video and initiate the filming process. GOBI Forage will be a member of a team headed by Mercy Corps that will be working on design and functionality of these alliances.

Gender

The project is organized to allow a good mix of well experienced scientists and young emerging scientists. The two project officers coordinating the forage and nutrition component are highly skilled women in their respective fields, reflecting a gender mix typical of professionals in the region (two older women scientists and one young male scientist). Over half of the outreach officers are women which work closely with all members of the participating herder groups.

The technology being delivered to the Mongolian herders will be supplied via radio, newspaper, and situation reports that will allow uniform accessibility for all gender and age classes. Training and outreach will be designed to insure that both male-headed and female-headed households are targeted since the number of female-headed households appears to be growing in Mongolia. The information disseminated by outreach activities will attempt to be gender responsive so that the needs of both men and women head of households will be addressed.

Working with Mercy Corps communication and outreach group, GOBI Forage will conduct a rapid appraisal of how the information being generated and delivered to the herder groups is used by the families and determine who in the family acts upon the information and the dynamics of the gender and age relationships so that dissemination and outreach products can be tailored to have the greatest impact across genders and age groups.

Policy

The Gobi Forage project is part of a large initiative of USAID called the GOBI II initiative which has key government organizations intertwined in the project. The herder associations that will be an integral part of the project will provide a direct feed back to the best design of information programs, interventions and government action resulting from the warnings provided to the communities. Policy makers of each of the critical institutions in the Ministry and the key Universities are involved in the overall planning process of the GOBI II project and are part of the information flow process in the GOBI Forage project. Our in-country project coordinator Mr. Sean Granville-Ross, works closely with the USAID Mission, the Ministry of Agriculture and the World Bank Sustainable Livelihoods program that directly advises the government on policy issues in the country insuring a direct conduit into government for policy relevant issues emerging within the project.

Outreach

Mercy Corp has an extensive outreach infrastructure as part of the Gobi Initiative with weekly radio shows, monthly newspapers and monthly television shows. They are planning on using our computer derived reports to move them into the communications network. During the past fiscal year, Texas A&M scientists met with Gobi Initiative personnel to discuss the best methods for displaying Gobi Forage output and maps and to develop templates for situation reports and maps. Discussions were conducted on the development of training manuals for training of herders in the use of Gobi Forage information in daily decision making for livestock. Discussions were also conducted on how GOBI Forage information will be incorporated into weekly news items reported in both the radio shows and newspapers currently used by the Gobi Initiative.

As reported, a video has been designed, filming completed and first draft finished which incorporates three topics which include the nature of disasters facing Mongolian herders, the GOBI forage NIRS and early warning technology, and the formation of herder marketing alliances. This video will be used to introduce herders to the need for technology like that being used by Gobi Forage, how the technology can be used to reduce effects of drought and cold winter (dzud) conditions on livestock, and how herder alliances could be used as a conduit for livestock decision making and marketing.

A Gobi Forage website (http://glews.tamu.edu/mongolia) has been developed where results and maps can be viewed along with general information about the project. The site has been partially translated into Mongolian and the remainder of the translation will be completed in the coming year.

Developmental Impact

Environmental impact. Early marketing and movement decisions resulting from reactions to the livestock early warning system and ultimate organization of marketing alliances will transform grazing pressure to reduce the impact on stability of ecosystems and retention of higher order grasses in these extensive production systems. Dissemination of information about forage amounts on a regional basis will provide more knowledge about where animals can be moved during drought or dzud conditions, thus reducing localized overgrazing. This in turn will assist in reducing soil erosion and improve rangeland recovery after drought.

Currently, very little information exists among herders about the actual carrying capacity or potential diet quality of the land where they graze. There has been an increased tendency since the droughts and dzuds of 1999 to 2001 for herders to increase the numbers of animals in their herds as a hedge against animal losses in the event of future droughts and dzuds. Informed stocking rate and diet quality/animal nutrition decisions by herders could be used to maintain fewer animals of higher body condition going into drought or winter, thus reducing death loss and increasing individual animal productivity while providing for greater ecological sustainability. Knowledge of forage quantity and quality are the foundation for identifying the economic threshold where individual animal versus unit area of land production meet. The information from Gobi Forage, along with training, outreach, and formation of herder alliances will help herders understand that this strategy of over stocking as a hedge against drought or dzud is not sustainable and can lead to long-term degradation of the system.

Contributions to U.S. agriculture. The technology being applied involves the first use of the CMORPH weather satellite technology for extensive grazinglands. If successful, this technology can be transferred back to the USA to serve the livestock industry by improving the emerging livestock early warning system in the USA. The CMORPH precipitation and US Air Force SNOW/ICE depth data also has application in USDA Risk Management Agency risk management tools for the ranching industry. A proposal will be submitted to USDA RMA to determine the effectiveness of the CMORPH data for biophysical indexing stocking rates. The Portable NIRS technology developed in this project could be used to provide rapid, near real-time monitoring tools for animal nutrition and rangeland health.

Agricultural sustainability. One of the major problems facing livestock production is the flight from extensive grazinglands to urban centers and large interest in peri-urban livestock agriculture. At issue is reduction of herder risk. The Mongolian LEWS system is being designed in such a way that the data is acquired and reported through the existing communication systems with limited continuing costs. TAMU has committed to a near-real time computing capacity to service decision making with fully automated computational systems that have very low maintenance needs. This has proven to be a very sustainable form of technology delivery thus allowing the host country to pursue outreach and capacity building. Organized marketing coupled with integration of new risk management tools, should offer a viable mechanism to allow herder groups to raise their livestock in a more sustainable manner and yet protect the fundamental production capacity of the resource.

Contributions to the host country. Since 1999, Mongolia has experienced a series of droughts and severe winters that has lowered the national livestock herd by approximately 30%. During this same period, the USAID funded GOBI Initiative Project managed by Mercy Corps has been actively forming herder cooperatives in six aimags. These cooperatives will act as a legal entities and will conduct business and financial transactions with the goal of improving enterprise diversification and augment existing enterprises. This will enhance their ability to sell products in a market chain and improve the business climate for herder families. One of the greatest sources of risk to livestock herders in Mongolia is drought, particularly in the spring, and winter ice/snow disasters. The technology developed by the GOBI Forage Project in the Global Livestock CRSP, should provide early warning of emerging short falls in forage supplies and development of areas with extensive snow coverage and depth to

create crisis situations where government can focus energies on priority areas where forage supply was low going into winter and ice/snow conditions are too extensive to escape their effects through movement of livestock. Simultaneously, the scientists in the GOBI Forage project will be building the capacity within key institutions in Mongolia to allow assessment of animal nutrient balance for the first time in remote regions and explore least cost feeding interventions via the use of fecal profiling technology with near infrared reflectance spectroscopy (NIRS) and computer simulation models. When coupled with the proposed Marketing Alliance organizations these technologies could strengthen the livestock sector and help spawn development of new industries such as processed feeds. Based on a PRA conducted prior to implementation of the project, we interviewed 10 herder groups involving over 120 families and over 200 individuals to determine if they would find the information generated by the GOBI Forage Project useful to their decision making. In all cases, the herder groups we interviewed identified the need for early warning and improved nutrition as major decision support needs in their respective grazing areas, regardless of the ecosystem that we were visiting.

When fully implemented, a large majority of the grazinglands will be covered by the GOBI Forage system and information will reach 85% of the herder community in the country via the rural business news network already in place.

The primary impact indicator will be the number of people aware of the early warning system and a measure of how they have changed their management practices to improve their financial status. Mercy Corps has collected an excellent baseline survey of all herders participating in GOBI II initiative and we will build upon this survey to quantify the impacts or contribution of the GOBI Forage project to the well being of the herders in the study. In the long term, we will use the number of herder alliances formed and length of time they are active as another measure of impact.

The Texas A&M team has trained two Mongolian scientists in the use of the Gobi Forage models and tools. This was the first phase of the program where scientists were brought to the US for advanced training and would then go back to Mongolia to train and mentor others in the use of the models and tools. Training of these two scientist and several others will continue during the next fiscal year. The Research Institute of Animal Husbandry and the World Bank Global Environmental Facility Lake Hovsgol Project have expressed interest in having personnel from their institutes travel to the US (at their expense) for future training sessions. We have also had discussion with the Director General of the Research Institute of Animal Husbandry for an internship program where undergraduate students from their program would work as summer interns to learn field sampling techniques for the forage sampling activities and to train in the use of NIRS for livestock diet quality analysis.

A drying oven and sample mill is being sent to the High Mountain Research Station in Ihktamir to facilitate cattle and yak feeding and NUTBAL validation trials in that region. These trials will be implemented with both station personnel and animals and with cooperation from local herders.

Linkages and networking. The primary linkages in this project is with the Mercy Corps, World Bank Sustainable Livelihoods Program, the USAID Mission, USDA, the Research Institute of Animal Husbandry of the Mongolia Agriculture University, the Mongolia Institute of Meteorology and Hydrology, and the World Bank Global Environmental Facility Lake Hovsgol Project.

Texas A&M and Mercy Corps currently have an MOU with the Research Institute of Animal Husbandry to conduct feeding trials for the NIRS equation development. The Institute through this arrangement also provides housing for a drying oven purchased by Gobi Forage as well as the lab facilities for the portable NIRS development.

In an August meeting with the Mongolia Institute of Meteorology and Hydrology an agreement was made to develop an MOU for sharing of forage production data collected by Gobi Forage and rainfall data collected by the Institute. The forage data will allow the Institute to have additional information for their annual assessment of livestock forage production for the country and the rainfall data will allow Gobi Forage to examine correspondence of the CMORPH rainfall data with

data collected at soum centers in the study area.

Collaboration with international centers and CRSPS. There are no major international center activities in the country. However, we will be collaborating with the SANREM CRSP on modeling interaction of forage conditions and potential disease spread between domestic livestock and wildlife, using the output of the GOBI Forage LEWS technology.

Meetings were held with personnel from the Bank Global Environmental Facility Lake Hovsgol Project to discuss areas of collaboration. The Lake Hovsgol project is collecting a large array of vegetation, soil, and climate data as part of their assessment of the effect of climate change on vegetation and herders in the Lake Hovsgol area of Mongolia. Although this project is outside of the region of study for Gobi Forage, the data being collected by the Lake Hovsgol project can be useful for further validation of the models being used in Gobi Forage. An agreement has been made to share data and to pursue avenues for funding a collaboration between the two projects.

Other Contributions

Support for free markets and broad-based economic growth. This project is directly targeted toward reducing risk and forming new marketing structures to help herders move to a free-market, entrepreneurial form of livestock production.

Contributions to and compliance with Mission objectives. The USAID Mission is a critical partner in this project and we are addressing their specific needs for the Gobi II Initiative via coordination with Jeff Goodson.

Concern for individuals. The technology being developed, outreach programs and improved marketing alliances will lead to opportunities for individuals to pursue personal development and accumulated of wealth that is independent of government mandates.

Support for democracy. Although GOBI Forage is not explicitly addressing democracy, the formation of marketing alliances allows a very local form of self-governance to emerge where they can market their goods and services as a unit independent of government.

Humanitarian assistance. Provision of early warning and affording herders and their families an opportunity to react to life threatening events can be considered a near-real time "humanitarian assistance" program.

Leveraged Funds and Linked Projects

The value of leveraging for GOBI Forage during 2005 was USD $765,339.

Dept Homeland Security – 503056, Resource Informatics for Defending Against Foreign, Animal & Zoonotic Diseases, Jerry Stuth, 10/2004-9/2005, $524,662.

USDA NRCS – 503093, Grazingland Spatial Analysis Tool, Jerry Stuth, 10/2004-9/2005, $100,000.

Kelleher Professorship, Resource Informatics for Ranching, Jerry Stuth, 10/2004-9/2005, $ 12,000.

Texas A&M University, Ann Zhang Stipend - Enhance Phygrow, Jerry Stuth, 10/2004-9/2005, $ 13,677.

Mercy Corps, Enhanced Nutritional Management For Herders in Mongolia, Jerry Stuth, 10/2004-12/2005, $115,000.

Training

Non-degree

Training in use of IPAQ GPS, ARCPAD and field sampling for PHYGROW, June 10-17, 2004 in Ulaanbaater, Mongolia. Facilitated by Doug Tolleson and Jay Angerer. Attended by 2 participants (2 female).

Training in conduct of diet-fecal pair studies, August 2005 in Ulaan Baator and Ikhtamir Mongolia. Facilitated by Doug Tolleson. Attended by 1 female participant.

Collaborating Personnel

United States

Angerer, Jay. Texas A&M University, Ecologist, Forage Leader, MS.
Conner, Richard. Texas A&M University, Agricultural Economist, PhD.
Hamilton, Wayne. Texas A&M University, Ecological Restoration, MBA.
Sheehy, Dennis. Private consultant, Ecologist, PhD.
Stuth, Jerry. Texas A&M University, Range Management, PhD.
Tolleson, Doug. Texas A&M University, Range Animal Nutrition.
Wu, Jimmy. Texas A&M University, Computer Science, PhD.
Zander, Kristen. Texas A&M University, Computer Science, MS.

Mongolia

Buxt, Stephan. Mercy Corps, Communications Tech Advisor.
Gombosuren, Udval. Inst. Animal Husb., Animal Science, PhD.
Luvsandorj, Bayan. Mercy Corps, Agricultural Economists, PhD.
Namkhainyam, Tsolmon. Mercy Corps, Internl. Business Admin.
Ross, Sean. Mercy Corps, Animal Science.
Tomon, T. Mercy Corps, Animal Science, MS.
Tsogoo, Damdin. Inst. Animal Husb., Ecologist, PhD.
Zimmerman, Steve. Mercy Corps, Agricultural Economist, PhD.

Collaborating Institutions

United States

Department of Rangeland Ecology
and Management
2126 TAES
Texas A&M University
College Station, TX 77843-2126

USDA-Foreign Agricultural Service
1400 Independence Avenue, S.W.
Washington, D.C. 20250 - 1008
Telephone: (202) 720-7233
TDD: (202) 720-1786
Fax: (202) 720-2658

Mongolia

Mercy Corps
24 Peace Avenue
Bayanzurkh District
Ulaanbaatar - 49
Mongolia
Phone: 976-11-461-145

Agricultural University of Mongolia
Research Institute of Animal Husbandry
Zaisan, Ulaanbatar-210153
Mongolia

World Bank Sustainable Livelihoods Program
Household Livelihoods Support Program Office
Address: Khuvsgalchdyn Avenue,
Ulaanbaatar-38, Mongolia
Contact Person: Mr Ch. Khurelbaatar, Director
Tel: 976-11-323500, 322465
Fax: 976-11-328107
Email: mppl@magicnet.mn

Institute of Meteorology and Hydrology
Address: Khudaldaany Gudamj-5,
Ulaanbaatar 210646, MONGOLIA
Tel: (976-11) 326614, Fax: 326611,
E-Mail: meteoins@magicnet.mn
Web: http://env.pmis.gov.mn/meteo

Hovsgol Project - GEF/Worldbank
c/o Geo-Ecology Institute-301
Baruun Selbe-13
Ulaanbaatar 211238
Mongolia
Telephone: +976-11-315786
Fax: +976-11-315786
E-mail: info@hovsgolecology.org

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Tolleson, D.R. and J.W Stuth. 2005. Near infrared spectroscopy of feces to predict diet quality in grazing animals: Development of a portable system. Proceedings of the XX International Grassland Congress, Dublin, Ireland

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Lead Principal Investigator

Jerry Stuth, Kelleher Professor, Department of Rangeland Ecology and Management, Texas A&M University, College Station, TX 77843-2126. Tel: (979) 845-5548; Fax: (979) 845-6430. Email: jwstuth@cnrit.tamu.edu.

Developing Institutions and Capacity for Sheep and Fiber Marketing in Central Asia

Narrative Summary

The project involves four activities that are being carried out in four regions of Kazakhstan and Kyrgyzstan. The year's research was the second stage in a three-year sequence of planned project activities.

The rural populations of Kazakhstan, Kyrgyzstan experienced dramatic decreases in living standards after the collapse of the Soviet Union and have yet to recover. Poverty levels have risen, life expectancy has decreased and infant mortality has increased. With the simultaneous deterioration of non-farm employment opportunities, strategies for poverty reduction and improvement of living standards for rural populations depend heavily on increasing food security and income from agricultural and livestock activities. The livestock sector is being reconstituted along market-led lines following the dramatic crash in sheep numbers during the early 1990s. Recent changes in the world markets for wool and other animal fibers have encouraged producers of sheep, goats and other fiber-bearing animals in Central Asia to seek innovations and developments, which will improve their livelihoods through more income from animals.

The goal of the project is to collaborate with wool and cashmere producers, buyers and processors in Kazakhstan and Kyrgyzstan to improve the marketing process and infrastructure and increase fiber quality and value. Currently, numerous deficiencies of the production and marketing system lower the quality and value of wool and cashmere and prevent Central Asian producers from competing in the domestic, regional and international market. The marketing problems identified in the course of our research include poor fiber preparation and sorting at farm level, poor sorting, testing and quality assessment of wool and cashmere by middlemen buyers, lack of objective laboratory testing and reliable market information on the quality of wool and cashmere, and lack of connections of producers to global markets. The project activities were designed to address these deficiencies by 1) training wool and cashmere producers in preparing and sorting fibers prior to marketing to increase quality and value; 2) training middlemen buyers in wool sorting and quality assessment; 3) collecting wool and cashmere samples, testing them using contemporary Australian-made equipment and sharing the test results with producers, buyers and researchers; 4) informing local and international wool and cashmere buyers about the quality and quantity of fibers produced in Kazakhstan and Kyrgyzstan to increase competition and prices; 5) informing Central Asian producers and buyers about the organization, quality standards, prices and trend on the global wool market.

Market development in this context is not a one-dimensional economic problem, but has social and institutional aspects which make producers cautious about risk. Most small-scale producers rely on their flocks to meet part of household food requirements which influences their decisions about breed selection and sales. Households often consist of multi-generation extended families which share assets and responsibilities while social insurance provision is extremely limited. Many sheep and goat producers live in geographically remote locations and are poorly served by transportation infrastructure, extension and veterinary services, financial services and communications. Although the region's pastoral traditions are centuries old, most contemporary producers' experience was formed under Soviet production and distribution systems which were not based on subsistence or market logic, and in which a few specialists managed most skilled tasks. For these reasons developed country marketing arrangements

and assumptions cannot be uncritically imported, or expected to result in immediate adoption. Solutions call for adaptive research and trails which can demonstrate benefits without increasing risks or requiring additional liquidity from producers.

Research

Activity One: Understanding Market Competitiveness in a Spatial Framework for Producers, Policy-makers and Investors

Problem Statement and Approach. Previous work suggests that producers can receive better prices for their fiber by offering better quality and volume to buyers of wool and cashmere. This activity will increase producers' ability to offer the higher quality products demanded by international markets and increase the flow of market information between producers and a broader global commercial sector. Marketing wools and fibers that are more attractive to buyers will have direct development relevance for producers who can expect to receive better prices and larger volume sales for their products, improving incomes. Physical characteristics of fibers, such as average fiber diameter, staple length, color and yield determine the value of the fiber. Producers should understand these characteristics for the fibers they are producing. Objective measurements that characterize these physical characteristics are an important component allowing the producer to increase his/her ability to effectively market his product and also improve the quality of his product. Preliminary data collected through interviews would provide information relative to what products are being produced and how these products are currently being marketed.

Data analysis on household surveys, Zhane Kurgan, Kyzl Orda Region, Kazakhstan. Analysis was completed with the survey of 50 livestock producer households in three sample villages in the Kyzl Orda study area. The questionnaire covered the period January 2003-April 2004, on the following topics: number of livestock owned (including breeds of sheep and goats); type of capital equipment used for livestock; crops and fodder grown; costs of transport for marketing livestock products; family and hired labor used for livestock; sales of live animals, wool, cashmere, camel hair, dairy goods, skins and hides (including prices obtained and places marketed); animals obtained. The sample was derived by choosing every nth livestock-owning household in each village from alphabetical lists kept by the local government administration.

Market information bulletins distributed and articles published. Producers, local traders and government officials in the target area of Kazakhstan were provided with 4-page market information bulletins and a poster in Russian. The bulletins explained the different prices paid by quality (diameter fineness), how to comb goats and how to sort raw cashmere on-farm. The posters were also distributed to other districts in Kazakhstan that produce high quality cashmere. Copies of the bulletins were sent to the Kyrgyz Sheep Breeders Association and to Mercy Corps in Tajikistan where cashmere goats are raised. These organizations publicized the information to farmers. Copies of the bulletins were also given to national media, (TV, radio and newspapers) for inclusion in their programs or articles.

To assess the impact of the Year 1 farmer training workshop on cashmere, in-depth interviews were carried out with six cashmere and wool collectors in three villages and Shieli town who re-sell to large scale traders in Turkistan city. Interviews were carried out with three village women in two villages, who had attended the April 2004 cashmere training workshop. Five male heads of farm households were interviewed from two villages. An evaluation was conducted with the organizer of the April 2004 workshop in Zhane Kurgan, who is a highly respected and influential local religious leader.

Samples (72) of cashmere were collected from the two target districts and tested. The results were made available to commercial buyers within Kazakhstan, Kyrgyzstan, Mongolia, Italy and UK – the latter two countries being the world's principal cashmere manufacturers outside of China. Contact with Italian companies was made through the World Bank Rural Development office in Almaty.

The joint GL-CRSP and Macaulay Institute meeting in Almaty was attended by the following donors: USAID, Canadian CIDA, British Embassy

and DFID, World Bank, Winrock International (USAID Farmer to Farmer) and Israeli international aid, Mashav. Six members of the GL-CRSP team made presentations and the project video was shown: "From Goat to Sweater: Training and information for Kazak farmers". Follow-up meetings were held between project team members and USAID Central Asia, British Embassy and UK Dept. for International Development (DFID), Farmer-to-Farmer program and the World Bank representative.

In Kyrgyzstan, the two UK cashmere consultants had discussions on cashmere market development with USAID Central Asian officers and project staff (Country Director for Kyrgyzstan, Agriculture, Rural Development, Agricultural Finance project, Fergana Valley project). A one-day cashmere training workshop for farmers and agricultural project staff was held in Osh, southern Kyrgyzstan, organized by the Agricultural Finance project (Winrock/ USAID).

The study tour to Mongolia was funded by the British Embassy (Kazakhstan and Kyrgyzstan) with additional funds provided by USAID Central Asia. The study tour introduced the system of Mongolian cashmere production, marketing, processing and export to a group of Kyrgyz and Kazaks with a special interest in developing a cashmere sub-sector in their own countries.

Participants on the Mongolia study tour represented four sectors: government policy, livestock research, commerce and farmers' associations[1].

Impact assessment of Year 1 farmer cashmere training workshop April 2004, Zhane Kurgan, Kyzl Orda region Kazakhstan. In May and June 2004 (after the workshop) traders as usual came to the villages from Turkistan city 80 km distant to buy goat fiber containing cashmere. They paid $2.90 to $3.70 per kg and increased the price as the buying season advanced. The Turkistan traders were offering $9-$11/kg for combed fiber but no one in the target villages prepared combed cashmere. Some villagers tried to comb using the combs distributed in the workshop but were probably not practiced so therefore they had difficulty managing the comb.

One of the village traders had collected 3 ton of goat fiber by motorbike, after the workshop. He said that reselling this to the Turkistan traders was more profitable than reselling coarse black sheep wool at $0.22 kg. A trader in Shieli town had collected 5 ton of shorn goat fiber. Some 15 local traders marketed an estimated 30-50 ton of goat fiber from Shieli district in 2004. The amount of cashmere in a kg of goat fiber is around 200gm, which means that 6 to 10 ton of cashmere would be available for processing from this district alone.

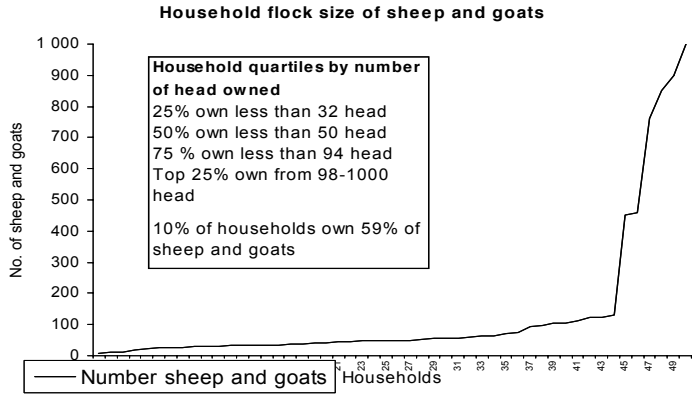
According to local village traders, collecting and bulking cashmere in the villages requires getting a prior agreement with the Turkistan buyers that they will buy at an agreed price. Some villagers will not stick to their word to sell to that particular collector at a pre-arranged price. The training workshops raised awareness among district government officials, local traders and some villagers, that the fiber produced by local goats was a valuable commodity. However, to realize higher prices, producers understood they would need to comb and sort raw cashmere. They are only willing to do this if they receive a "guaranteed" higher price from buyers at the beginning of the season.

Village women's reaction to the farmer training workshop was that they were very interested and excited that they could get the same amount of income as in China, as was shown on the GL-CRSP video. However, they commented that producers would have collected down and sold in bulk if a trader had promised to buy combed cashmere from them. When the buyers come in spring from Turkestan, they bring cash and so villagers quickly

Table 1. Household ownership of livestock by village.

Village	Sheep	Goats	Cattle	Horses	Camels
Kruash					
Sum	947	583	82	16	3
Mean	56	34	5	1	0.18
Minimum	0	12	1	0	0
Maximum	400	180	18	3	1
Kosenka					
Sum	1280	553	72	23	0
Mean	71	31	4	1	0
Minimum	7	0	1	0	0
Maximum	650	250	10	8	0
Jailma					
Sum	2008	1331	84	13	1
Mean	134	89	6	1	0.07
Minimum	0	5	0	0	0
Maximum	700	400	20	5	1

Figure 1. Frequency distribution of sheep and goat owned by sample households.



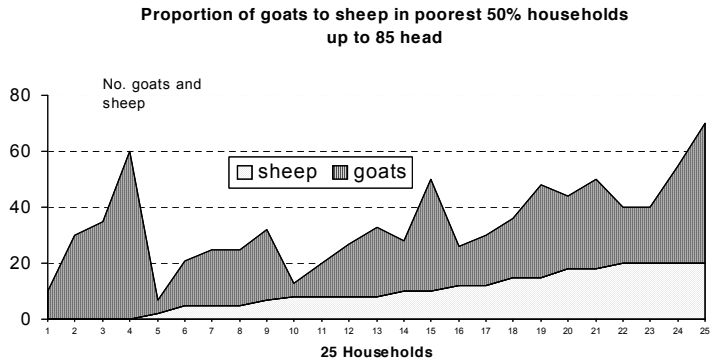
shear their goats and sell the fleece. As villagers are not sure if traders would buy combed cashmere, they are not willing to go to the effort of combing with the risk that traders will not buy. Villagers' priority for getting increased prices was that people needed to form marketing groups, which they would be interested in doing if a trader came in March and offered a price for combed cashmere. In Year 3, the project is arranging for one or more buyers to pre-arrange prices and quantities for purchase from village producers, through local traders or informal village marketing groups.

Data analysis on household surveys, Zhane Kurgan, Kyzl Orda Region, Kazakhstan. In Zhane Kurgan district, village livestock ownership is dominated by sheep and goats (Table 1). All households had at least one or two milk cows, to supply dairy products for home consumption. Only half the households owned horses, which are used for riding. Camels were owned by 8% of sample households.

Ownership of small stock is sharply differentiated, with a skewed distribution ranging from 0-700 sheep and 0-400 goats owned (Figure 1). The majority of livestock owners have between 20-100 small stock, while a small minority own the greater part of the small stock population. This distribution pattern implies that averages of the whole sample will not distinguish between the distinctly variable livestock ownership pattern.

Smaller flocks have proportionally more goats than sheep, as goats reproduce faster, cost less to buy and are easier to manage than sheep (Figure 2). Since decollectivisation a decade ago, most rural households have been trying to build up their private livestock holdings. In-depth field interviews have revealed that acquiring and breeding goats has become the most effective means for small-scale farmers to initially accumulate livestock.

Figure 2A & B. Household ownership of sheep and goats by flock size in survey sample (note: scale difference from poorest 50% to richest 50%).



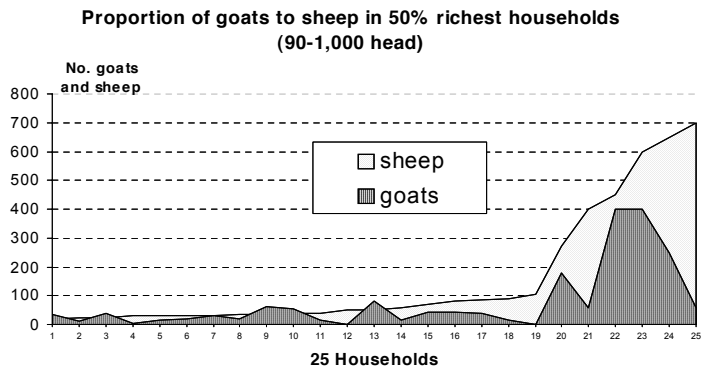
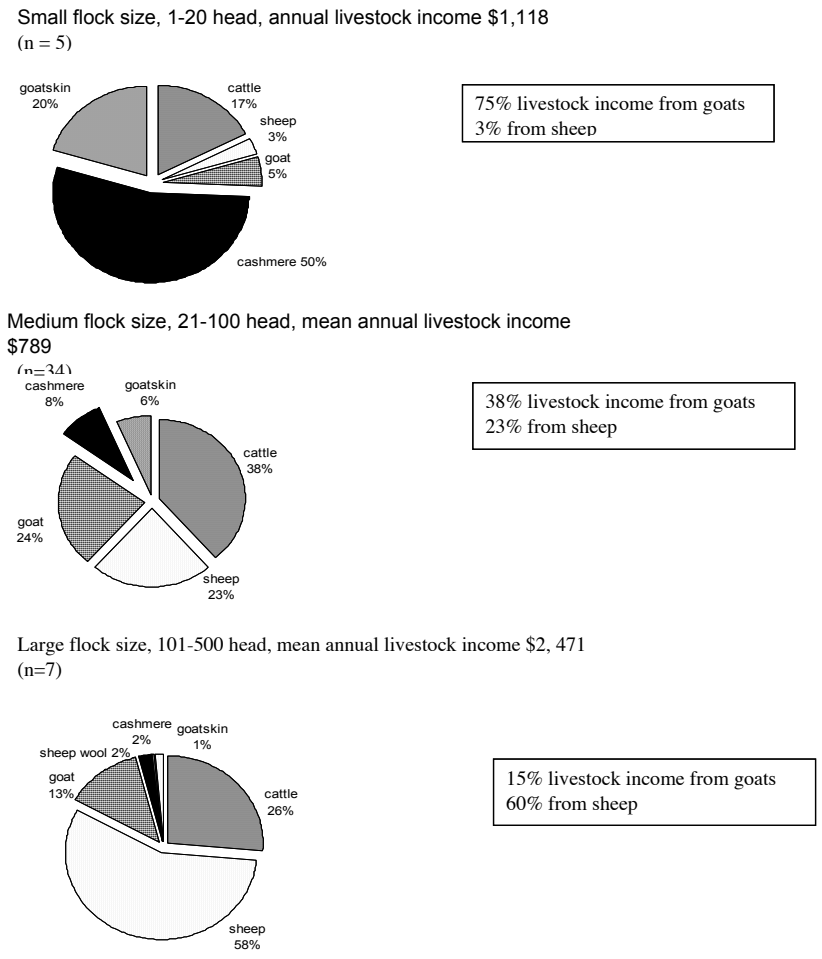


Figure 3. Proportion of income (percent) from sale of livestock and products, by flock size.



Overall, sheep and cattle provide the highest sources of income from livestock. However, this masks the key differences in flock species by flock size, as poorer household concentrate on goats while the households with greatest flock wealth have far more sheep than goats. Income from goats is therefore relatively more important in the smallest flocks. As households become wealthier, they keep more sheep than goats as sheep are the preferred species for Kazakh pastoralists and command a higher market price for their meat, compared to goats. Figure 3 shows the relative balance of income obtained from the different flock species of goats, sheep and cattle, by flock size category.

The data on income and expenses suggest that livestock-owning households are spending about 40% of income on livestock expenses alone without taking into account any other household expenses such as clothing, health, education, etc.

Initiate work in Tajikistan. Planned activities in Tajikistan on cashmere farmer training and marketing could not be implemented. The unrest in March associated with the change of government in Kyrgyzstan led to Aga Khan Foundation Geneva withdrawing their invitation due to their concerns over security.

Assessments of specialty fibers were planned to start in Gorno Badakshan region of Tajikistan, with the Aga Khan Foundation. This was not accomplished due to a management change in the collaborative organization and their resulting decision to accord a lower priority to cashmere marketing

Cashmere assessment. Within the target region of Kyzl Orda, 72 samples of raw cashmere were collected from 19 farmers' flocks. In Zhane Kurgan district, CRSP project team members collected 54 samples from two villages; in Shieli district, 18 samples were collected from 5 villages by the district agricultural office. Two types of test were carried out on these samples. Only a small number of cashmere samples could be tested, compared to the several thousand fine wool tests carried out due to funding limitations.

All samples were first assessed by subjective methods (see Table 2). Subjective cashmere assessment involves a visual analysis of the cashmere sample or fleece. The assessor uses their skill and experience (with reference to standard samples) to estimate the mean cashmere diameter. The cashmere is then classified into hosiery cashmere with a mean cashmere diameter less than 16.5 micron (µm), or weaving cashmere (mean cashmere diameter is more

Table 2. Results of subjective assessments of cashmere from two districts in Kyzl Orda region, Kazakhstan n= 72; 63 female, 9 male goats.

Fiber Diameter	No.	Percent	Color	No.	Percent
Hosiery <16.5 micron	58	78	Colored	48	67
Weaving 16.5 to 18.5 micron	16	22	Offwhite	11	16
			White	13	17
Total	**72**	**100**		**72**	**100**

than 16.5 µm but less than 18.5 µm. The terms "hosiery" and "weaving" describe the mean fiber diameter in terms recognized by the commercial industry.

Mean fiber diameters estimated at more than 18.5 micron (µm) are not normally considered cashmere in the commercial industry. Cashmere of more than 18.5 µm can also be traded (generally at a low price) and may be used to blend with other higher value cashmere or wool. Cashmere fiber color is also estimated visually and can be classified into: (a) White (both guard hair and cashmere are white) (b) Grey or off-white (very few colored guard hairs, cashmere very pale to white) and (c) Colored (guard hair and cashmere both colored). For simple on-farm assessment it is best to concentrate on classifying the fibers to only two or three colors.

Cashmere fiber is generally dyed to a color darker than its natural shade as bleaching the fiber prior to dyeing reduces the soft feel of the cashmere. The soft feel or 'handle' of cashmere is the reason it is so highly valued as a textile fiber. Therefore, white cashmere is most valuable to processors as it can be used undyed or dyed to very pale tints. Table 2 shows that 17% of the samples were white.

A sub-sample of 23 was then tested, including at least one sample from each separate flock (two to four samples from flocks in which a number of samples had been collected). The sub-sample was tested on an OFDA 100 (The Fibre Lab, Aberdeen, UK). The OFDA 100 results on the 23 sub-samples showed a mean fiber diameter of 15.9 micron, with a range from 13.1 to 18.5 micron.

The length of the samples measured was within acceptable commercial limits and the occasional animal with longer fiber (provided it retains a cashmere type crimp and not a tendency to mohair style) will increase the quality rather than decrease it. Most processors prefer cashmere to be 40-60 mm in length pre-processing (i.e. in the raw state). This is because cashmere is normally woolen spun and shorter or longer lengths are more difficult to process. Conversely, cashmere that is longer than 60 mm can have high value for blending as the longer fibers can aid in the spinning of very fine yarns.

The fiber diameter means measured by OFDA 100 indicate that the fiber tested from the Kazakh goats fell within the definition of the best quality, i.e. hosiery cashmere. There has been a trend internationally to prefer finer cashmere of 15.5 micron (µm) or less and the fiber from Shieli district falls within that preference. Some of the samples are super-fine e.g. 13.3 µm.

All the samples tested showed a low Standard Deviation and percentage Coefficient of Variation, indicating that the fiber diameters are evenly distributed. This consistency in fiber diameter variation is preferred by commercial processors as it makes a yarn with less inconsistencies and a more predictable finished product.

The lack of an apparent relationship between fiber diameter and animal age indicates that the flock make-up does not affect the overall fiber quality and the animals currently owned by the villagers are suitable for cashmere production.

Mongolia cashmere study tour. Mongolia provides a highly relevant model for how a Central Asian cashmere industry can benefit producers, small businesses, domestic processors and state export revenue. The cashmere sector in Mongolia has been developed over the past several decades and cashmere has become the single biggest source of income for livestock-owners. Mongolia's experience offers much that can be applied to Central Asia. Mongolia formerly had a socialist command economy but has undergone transition to a market economy, has large areas of pasture, many livestock-dependent households and local breeds of cashmere goats, all common also to Kyrgyzstan and Kazakhstan.

Central Asian participants understood from what they observed in Mongolia that there is

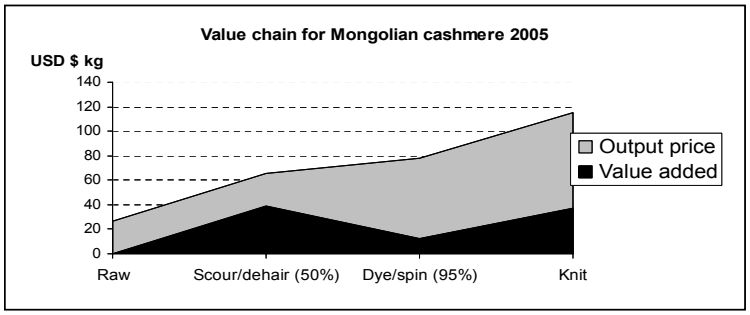
potential to develop the cashmere sub-sector in Kyrgyzstan and Kazakhstan. Following are the main priorities identified by the participants from the study tour.

Systematic assessment of the quality and quantity of cashmere available in both countries is a first priority for attracting international buyers desiring high-quality cashmere and to interest foreign investors in Kyrgyzstan and Kazakhstan. Buyers and investors require objective measures of what is available and where this can be purchased. It is already known that the quality varies tremendously by region within each country, due to the influence of angora-type breeds of goats from the Soviet period which produce cashgora, a low-quality fiber with much less value on international markets. Ultimately, the value of cashmere is determined by its quality, assessed by standards set by industrial processors in response to their international customers, the manufacturers. At present neither Kyrgyzstan nor Kazakhstan has a cashmere assessment laboratory. If alternative, higher-profit markets are to be accessed instead of exporting raw and untested cashmere for a low price to China, then national assessment laboratories will be required.

Mongolia has developed a regional cashmere collection and market price information network since the end of the centralized state collection system in the early 1990s. This provides a model for what should be implemented in Kyrgyzstan and Kazakhstan.

There is a need to attract foreign investment into processing within Kyrgyzstan and Kazakhstan. There is now only one small processing factory, in Naryn, Kyrgyzstan. Nearly all the cashmere from these two countries is now exported raw to China, Mongolia, Iran and other countries. The loss in value-added along the market chain is considerable as suggested by the Mongolian example (Figure 4).

Figure 4. Increase in price per kg of Mongolian cashmere, along marketing chain from raw (producer price) to final knitted garment.[2]



Links between Mongolian and Central Asian cashmere businesses should be encouraged. Given the degree of over-capacity in Mongolian processing factories and the difficulty for them to match prices for raw cashmere with Chinese buyers, it could be profitable for Mongolian companies to set up factories in Central Asia where the raw material price is lower. Another option would be for Mongolian processors to source high quality raw cashmere from Central Asia, rather than as at present, being supplied only with poor quality cashgora from Kazakhstan.

Alternative international buyers are needed, in order to compete with Chinese buyers and raise producer prices for Central Asian livestock owners. Several large processors are located in the USA (e.g. Dawson-Forte and California Cashmere). They will need to be assured of the quality and quantity of cashmere available in Central Asia.

There is an opportunity to sell into the world niche market for premium quality cashmere available in Central Asia. High class and exclusive European, USA and Japanese fashion houses demand the best quality of cashmere and are prepared to pay premium prices for this. All parties met in Mongolia confirmed that high quality cashmere with diameter of 13-14 micron will always find a market internationally. Even relatively small quantities of this very fine cashmere would be of interest to European and USA buyers, who need supplies of this scarce commodity that is now mostly controlled by Chinese processors.

Researchers in each country have recently established small elite cashmere breeding flocks, supported with international funding and technical assistance. There is superior local genetic material available that can be used to select for more uniform and high-quality breeding stock. An expanded elite breeding program would have a greater impact on more livestock-raising households in both countries,

helping livestock-owners increase their income by producing better-quality cashmere.

Farmers need training on sorting and to receive up-to-date market price information in the buying season, to get better prices. Farmers need to be encouraged and trained to set up village-level bulk marketing associations, to get better prices.

Mapping the suitability of Kazakhstan eco-regions for pastoral livestock. We sought to use spatial vector data, remotely sensed images, and information from the literature on historical distributions to classify World Wildlife Fund terrestrial eco-regions as to their suitability for pastoral livestock breeds. The objective of survey data collection is to generate data on the development of sheep farms in the pilot regions. The lack of information on the newly developing sheep farms in Kazakhstan is a major obstacle to establishing contacts with sheep producers and improving the organization of wool marketing. Liba Brent started to collect data on sheep and goat farms in the three pilot regions in the summer of 2003 and 2004. The data collection includes mapping the location of the farm, name of the farmer, the number of sheep and goats and their breeds, and other basic information about the farm. This information will provide a valuable overview of the development and characteristics of sheep farming in each region.

Of the 867 eco-regions mapped throughout the world by the World Wildlife Fund, all or part of the 20 eco-regions occur within Kazakhstan, including a region for water bodies. Three eco-regions dominate, Kazakh steppe, Kazakh semi-desert, and Central Asian northern desert. The eco-regions have been clipped from the world-wide database, placed in our GIS, and detailed descriptions of each by the map makers have been added to our files. Maps have been acquired showing breed distributions for goats and sheep during the Soviet era, and the distributions of breeds of cattle, camels, sheep and goats have been reviewed in Dmitriev and Ernst (Animal genetic resources of the USSR, FAO, Rome, 1989). Livestock statistics for the oblasts of Kazakhstan have been acquired. Some literature on the tolerances of livestock has been located.

Wool Assessment. In order to generate objective information about the quality of wool in Kazakhstan and Kyrgyzstan, the team planned to collect approximately 3,000 wool samples from 10-12 farms in the Dzhambul, Aksui and Raimbek regions of Kazakhstan. The samples were to be tested using OFDA 2000 and compared with sample tests conducted in 2004.

The team planned to enter the results into a database and share the information with producers, buyers and scientists. These groups were encouraged to use the information to improve various aspects of wool production and marketing. The producers could use the data to compare their wool to wool produced on surrounding farms and on farms in other regions. They could use the comparative data to bargain for higher price in case their wool was of a higher quality. The producers and sheep-breeding scientists could use wool data on breeding animals for selection. The buyers and processors can use the information to assess wool quality on different farms and differentiate prices paid to farmers based on differences in quality. The project plans to make the data available to international buyers to generate interest in Kazakh and Kyrgyz wool on the world market.

Liba Brent and local collaborators in each of the regions collected 4,014 samples from 41 farms from four regions of Kazakhstan: Dzhambul, Aksui, Rainbek and the Dzhambul oblast. The samples were collected randomly, from 1-10% of live animals depending on the size of the flock. The collection took place in May and June 2004 prior to shearing. Four merino-breeding farms in the Dzhambul oblast of Kazakhstan and in the Aksui region were added to the pilot group of farms in 2005. These farms have some of largest flocks of merino sheep in Kazakhstan and it was important to test their wool and provide the producers and potential buyers with objective information on wool quality.

In addition Liba Brent collected samples from wool bales on three merino-producing farms in Kyrgyzstan. Although sample collection in Kyrgyzstan was not part of the 2004/05 workplan it advanced the project objectives and provided direct benefits to Kyrgyz wool producers and buyers in the form of objective wool data. In August 2005 the Kyrgyz farms had around 50 tons of wool for sale but lacked objective information on quality which

jeopardized their marketing efforts. Liba Brent collaborated with Evgenia Lushikhina, a scientist from the Kyrgyz Academy of Sciences who manages sheep-breeding on the farms, to organize sample collection and testing. The test results were delivered to the producers and made available to potential wool buyers such as the ST Group Company in Kazakhstan. The team plans to continue sample collection in Kyrgyzstan during the third year of the project.

During sample collection, Liba Brent discussed wool production and marketing with the producers, informed them about global market standards and prices and showed a documentary video on wool pools in the United States and on the Yocom McColl independent fiber testing laboratory in Denver, Colorado.

The 4,014 side samples collected from live animals in Kazakhstan, and the 400 grab samples collected from wool bales on farms in Kyrgyzstan were tested at the wool laboratory of the ST Group Company using OFDA 4000, an Australian-made equipment which was purchased by the company in the spring of 2005. Last year, the samples were tested using OFDA 2000 at the laboratory of the Kyrgyz Sheep Breeders Association in Kyrgyzstan. In order to compare the test results of the two laboratories, 200 samples collected in Kazakhstan were divided in half and tested using OFDA 2000 in Kyrgyzstan and OFDA 4000 in Kazakhstan.

The two OFDAs use different methods of testing. The OFDA 2000 tests greasy wool by scanning the entire staple. The OFDA 4000 uses washed, minicore samples. Regardless of the differences in the testing process, we expected to obtain comparable results with differences in the magnitude of +/- one micron. However, the test results showed much larger differences. The tests from OFDA 4000 were consistently 2-3 micron higher than the results obtained from OFDA 2000. The average measurement of the 200 samples obtained from OFDA 4000 was 24.9 micron compared to 21.5 micron from OFDA 2000.

Although some of the difference can be attributed to the different testing methods, especially the difference in testing washed and greasy wool, additional tests need to be conducted to explain these inconsistencies and assist the Kyrgyz and the Kazakh laboratories in improving its testing methods.

The ST Group Company laboratory contacted the distributor of the OFDA 4000, the INTERWOOLLABS, to re-check the calibration of their machine. The experts from INTERWOOLLABS confirmed that the OFDA 4000 operates correctly. It is possible that the technician at the KSBA wool lab used an incorrect coefficient (the relation of greasy to washed wool) which affected the results. We plan to investigate this and other hypotheses and conduct additional tests of the samples at the Yocom McColl laboratory in Denver, Colorado. The objective is to continue to work with both laboratories to ensure that they conduct accurate testing.

OFDA 4000 Test Results for Farms in Four Regions of Kazakhstan. The Pioneer and Merke farm are located in the Dzhambul oblast, 350 km west of Almaty, near the Kyrgyz border. Both farms breed the Southern Kazakh Merino sheep and are former state breeding farms[3]. The Merke farm has around 15,000 sheep and the Pioneer farm has around 8,000 sheep. These numbers place them among the largest farms in Kazakhstan. In 2005 both farms signed a contract with the ST Group Company agreeing to sell them their 2005 wool clip and in turn received a pre-payment. The ST Group Company and the farm directors were interested in obtaining objective information on wool quality and decided to collaborate with the GL-CRSP project to collect wool samples at the farms during shearing. Samples at both farms were collected by the chief zoo technicians in June 2005 and tested in September 2005 using OFDA 4000.

The test results have shown that the farms have some of the finest and longest wool in Kazakhstan. Samples collected at the Merke farm are on average 14.72 mm longer than the average length of all samples collected, which is 81.58mm. The 24.6 fiber diameter is close to the 24.88 average. Although the Pioneer farm shows a low fiber diameter of 23.1, samples at this farm were not randomly collected. The chief zoo technician sampled the sheep with finer wool and the measurements are not representative of the farm's flock. Both farms breed the Southern Kazakh Merino sheep and it is likely that the wool

quality on the Pioneer farms is similar to that of the Merke farm. The wool at both farms is well sorted and graded, which is a legacy of the Soviet wool production system. The Merke farm continues to sort and bale the wool as it did during the Soviet period and has the best organized shearing, sorting and baling process in Kazakhstan.

At $1.36 per kg in 2005, the income from wool production was around $80,000 for the Merke farm and around $40,000 for the Pioneer farm. The farm directors realize that under increased market competition and improved quality the wool prices may be higher. One way of increasing competition is to provide objective information on the wool to potential foreign buyers. The farms plan to collaborate with the GL-CRSP project on sample collection and testing in the spring of 2006 to improve their marketing options. The GL-CRSP project will assist them with correct wool sampling, testing and advertising their wool internationally. This could bring international wool buyers to Kazakhstan, create competition for local and Chinese buyers, increase wool prices and improve the access of Kazakh wool producers to the world market.

The farms in the Dzhambul region, Almaty oblast, are located around 160km northwest of Almaty. With the exception of the Kurty farm which is a cooperative, all other farms are private and each of them has around 500-1,000 sheep. The private farms were formed after the privatization of the Roslavl state farm that bred Kazakh Finewool sheep. The farmers, who previously worked for the Roslavl farm, privatized the sheep, pastures and sheep pens and set up individual private farms. Seven out of the ten farms are located in the same general area near the Roslavl village, about 2 miles from each other.

The farms originally started with flocks of purebred Kazakh Finewool sheep which they acquired from the Roslavl state farm. After ten years of sheep farming the farms have 10-20% of crosses between the Kazakh Fine wool and the native coarse wool breeds. As a result the quality of wool has declined. Crosses between the Kazakh Fine wool sheep and the native coarse wool, black-faced sheep, the Kazakh Fat-Tail, are sometimes the result of poor breeding and flock management practices. On other occasions farmers deliberately cross the two breeds because they prefer the hybrid sheep which are larger and produce lambs that are more resilient and require less maintenance. The quality and value of wool from the crossbred

Wool sample collection at the Dzhambul region, May 2005. Photo by Liba Brent.

Table 3. Dzhambul region, Almaty oblast, side samples collected by Liba Brent.

Dzhambul region

Name of Farmer/Farm	# of samples	Sheep type	Fiber diameter	Length
Kurty Farm	184	Mix	23.9	83.5
Kusainov	40	Mix	24.6	81.2
Surtaev	80	Mix	25.1	80.9
Baimukhaev	99	Mix	25.2	83.9
Tuleukulov	95	Ewes 2-3-4-5	25.3	81.2
Fazyl	95	Mix	25.5	84.6
Nurgaliev	53	Ewes 2-3-4-5	26.2	83.7
Abenov	49	Ewes 2-3-4-5	26.4	90.0
Dusembiev	63	Mix	26.7	85.7
Sarsebaev	61	Ewes 2-3-4-5	27.0	87.1
Averages	819		25.6	84.2
Average for 41 farms	4014		24.88	81.58

sheep is lower and there is no demand for colored wool of the native sheep. However, some farmers claim they can make more money selling live hybrid or black-faced sheep than the merinos because the black-faced sheep are larger and their meat is preferred by many consumers.

A yearly income from wool for a farm with 500 merino sheep is about $1,750 (assuming the sheep produce 3.5kg of wool that sells for ~$1/kg) and the income from selling live animals is around $16,250 (assuming the farmer has 500 lambs, keeps 250 female lambs for replacement and personal consumption and sells 250 young males and 75 old ewes @ $50 per head). This means that wool represents about 10-11% of the farm's income from sheep production. It is likely that many smaller, private farms will eventually focus on meat production as opposed to wool, especially if wool prices remain low and if there continues to be a greater demand for the larger, black-faced breeds of sheep on the market. The GL-CRSP project plans to collect wool samples from the farms in the spring of 2006, compare the results with the 2005 data to determine changes in wool quality and interview the farmers about their breeding preferences. This information will help to estimate the trends in sheep and wool production on small and medium farms. At the same time, wool production in Kazakhstan and Kyrgyzstan has increased and many medium and large farms continue to breed merino sheep for wool.

According to recent GL-CRSP research, sheep breeding for wool and meat seems to be most profitable for Kyrgyz farmers. The GL-CRSP small grant project led by Bob Stobart, Malcolm Childress and Akylbek Rakaev studied the economics of sheep production in Kyrgyzstan in 2002. The objective of the project was to compare relative profitability of sheep production focused on meat, wool and wool and meat. The data showed that all three directions of sheep productions were profitable. The most profitable was the production of sheep for both meat and wool, the production of sheep for meat came second and the least profitable was the production of sheep for wool. The high profitability of dual-purpose sheep resulted from the low costs of wool production - shearing, preparation and marketing of wool represented only 0.4% of total production costs.

According to interviews with sheep producers in Kazakhstan, most of them would be interested in producing dual-purpose animals with white fleece and focus on sales of both meat and wool. However, there is a lack of dual-purpose breeds in Kazakhstan due to the Soviet era priorities to breed for wool and the lack of financing for alternative breeding programs in the post-Soviet period. The lack of dual-purpose sheep leaves the farmers with the option to focus on wool breeds that are smaller and produce less meat, or breed the native black-face sheep whose wool has little or no market value. The WOOL project collaborates with Dr. Kasenov, a scientist from the Sheep Breeding Institute, who has been working to develop a white fleece dual-purpose breed by crossing German Meat Merino sheep with the Kazakh Finewool sheep. The project team works with Dr. Kasenov to inform farmers about the new dual-purpose breed and gives farmers information about where to purchase the sheep if they choose to pursue the meat and wool direction.

Although the profitability of each breeding direction fluctuates with the value of wool and meat on the market, the improvements in wool marketing infrastructure and the recent increases in domestic wool processing capacity are expected to lead to increases in the price and demand for wool on the local market. In 2005 wool production in Kazakhstan was 24,800 tons, a 5.2% increase from 23,500 tons in 2004. This trend suggests that wool continues to be an important agricultural commodity and marketing improvements can help farmers to receive fair prices for wool. If an increase in wool quality and competition on the local market led to a $0.25/kg increase in wool prices – which is not an unrealistic estimate given that Kazakh and Kyrgyz wool is now priced $0.50 - 0.75/kg below the world market price - a medium farm with 800 sheep would receive additional $700 in income from wool. This sum represents a considerable purchasing capacity in Kazakhstan and Kyrgyzstan. At a national level, a $0.25/kg increase in wool prices would amount to additional $6.2 million in revenue from wool sales in Kazakhstan and $2.5 million in Kyrgyzstan. In combination with improvements in sheep breeding

focused on increasing meat production of white-faced, merino sheep, Central Asian farmers could benefit from increased meat production without having to give up their income from wool.

Based on the 2005 data, the fiber diameter of wool produced by private farms in the Dzhambul region varies from 24.6 to 27 micron, the length is close to the 84.2 mm average. Although on the world market the 24 and 27 micron wool sells for different prices, the Kazakh wool market does not yet have the capacity to accurately evaluate wool and diversify prices paid to farmers. One of the weak links in the marketing system is middlemen buyers who purchase wool from private farmers. The middlemen are often seasonal workers who lack the skill to evaluate wool quality. They usually offer the same price to all merino farms in the region in spite of the differences in fiber diameter, length, yield and the quality of wool preparation. This type of pricing policy lowers incentives for farmers to focus on improving wool quality through selection and proper handling. The GL-CRSP project facilitates market development by training middlemen buyers in sorting and evaluating wool and by providing them and the producers with objective information about wool quality.

The highest quality wool in the Dzhambul region is produced by the Kurty cooperative farm. This farm has around 10,000 sheep. It was a state breeding farm of the Kazakh Fine wool sheep during the Soviet period and relies on a long tradition of producing merino sheep for wool. It employs breeding specialists, collaborates with scientists from the Sheep Breeding Institute, practices artificial insemination, produces breeding rams and sorts and bales the wool at the farm. The farm receives 25-35 cents per kg of wool above the local market price paid to private farms that produce less wool and do not sort or bale it.

As a rule, the former state farms produce higher quality wool than the new private farms because they continue to rely on the Soviet tradition and technology of wool production and preparation. This includes breeding merino sheep for wool and sorting, classing and baling the wool at the farm. Former state farms such as the Kurty farm also benefit from having access to shearing and sorting facilities, warehouses and old Soviet wool balers. Those farms that preserved several thousand sheep also benefit from economies of scale.

The farms in the Aksui region are located about 250 km northeast of Almaty. The farms breed Kazakh Fine wool sheep and all are private farms. The Kopa farm is a former state breeding farm of the Kazakh Fine wool sheep and based on the sample test results produces 23.7 micron wool, which is almost 1 micron finer than the total average. The wool is 74.2 mm long, or 10 mm shorter than the total average. The shorter length may be the result of the time of sample collection. Samples at the Aksui farms were collected in the beginning of May, a month earlier than at some other farms.

The Raimbek region is located at the south-eastern corner of Kazakhstan near the Chinese border.

Table 4. Raimbek region, Almaty oblast, side samples collected by Liba Brent.

Raimbek region

Name of Farmer/Farm	# of samples	Sheep type	Fiber diameter	Length
Zhylysai Farm, Dauletbakov	41	Mix	24.3	71.7
Kumtekei	50	Mix female lambs	24.5	79.8
Rachmetov	143	Mix, male/female lambs	24.6	82.9
Bukienov T.	52	Mix	24.7	78.3
Bakaev, Saken	62	Mix	24.8	82
Uzumbulak	163	Mix	24.9	80.175
Aldzhanbaev T.	55	Mix	25.4	74.8
Nogaibaev M.	75	Mix	25.9	79.8
Moldesanov Erganat	56	Mix Ewes 2-3-4-5	26.4	77
Zhylsai Farm, Duisekov K.	39	Mix	26.4	89
Sarzhaz	4	Breeding Rams	25.1	80.2
Averages	741		25.2	79.4
Averages for all 41 farms	4014		24.88	81.58

Sorting wool at the Uzumbulak farm, June 2005. Photo by Liba Brent.

The farms in the region produce the Arkhar Merino breed of sheep that was developed through breeding the wild Arkhar sheep with Australian merinos and other breeds. Farmers in the Raimbek area continue to breed purebred merino sheep although hybrid sheep are becoming more common as private farms are not committed to a rigorous selecting for wool. The Uzumbulak cooperative breeding farm produces wool of similar quality as some of the private farms that surround it, however it has the capacity to sort and bale the wool on its premises. The Uzumbulak farm sold sorted and baled 2005 clip to the ST Group Company for $1.20/kg and the surrounding farms received $1 for unsorted, unbaled wool. The Uzumbulak farm collaborates with scientists from the Sheep Breeding Institute and is interested in breeding for super-fine wool.

These Aksui region farms are located 250-200 km northeast of Almaty. The largest is the Almaty farm that has around 20,000 sheep. The farm sold wool to the ST Group Company for $1.35-1.40 per kg in 2005. The wool produced by the Almaty farm is about .9 micron coarser than the total average. This may be due to the breeding selection that is oriented towards meat merino or dual-purpose sheep that are larger and produce semi-fine wool. Dr. Kasenov from the Sheep Breeding Institute is in charge of sheep-breeding at the Almaty, Eskelde and Arai farms and his preferences for the meat merino breed are shaping selection at the farms.

These farms are located in the Aksui region and collaborate on sheep breeding with sheep specialists from the ST Group Company. The company purchased over 200 merino sheep from Australia in August 2005. They will be used to improve breeding selection at the merino breeding farms in Kazakhstan. The ST Group Company seeks to invest into merino sheep-breeding to ensure the production of quality wool for processing which is essential for the company meeting the quality requirements of its customers[5]. The company organized a meeting with large breeding farms in September 2005 and offered them to purchase imported Australian merino rams for $4,000 and repay the company with wool. The efforts of the ST Group Company to influence breeding selection towards fine wool production demonstrate the commitment of Kazakh buyers and processors to

Table 5. Aksui region, Almaty oblast, side samples collected by Dr. Kasenov.

Name of Farmer	# of samples	Sheep type	Fiber diameter	Length
Myngasarov	122	Mix	24.4	89.5
Karachok	134	Mix	24.8	70.3
Eskelde	199	Mix	25.2	88.5
Arai Farm	169	Mix	25.3	95.9
Almaty Farm	256	Mix	25.5	74.3
Iris Farm	103	Mix-m	26.2	78.3
Sarybulak Farm	20	Mix	27.2	98.2
Averages	1003		25.51	84.97
Averages for all 41 farms	4014		24.88	81.58

improving wool quality and helping Kazakhstan to remain one of the main wool producing countries on the world market.

OFDA 4000 Test Results for Farms in Two Regions of Kyrgyzstan. Liba Brent collaborated with Dr. Evgenia Lushikhina, a merino breeding scientists at the Kyrgyz Academy of Sciences, to organize collection of wool samples on farms in two regions of Kyrgyzstan, the Talas region in western Kyrgyzstan and the Issyk Kul region in eastern Kyrgyzstan. Dr. Lushikhina is a leading sheep scientist who has worked on Merino breeding farms in Kyrgyzstan for several decades. Mrs. Lushikhina has connections to farms in different regions in Kyrgyzstan and has been trying to help farmers market their wool for higher prices. Because of the lack of competition on the local wool market in 2005 caused largely by the decline in Chinese demand, many of the merino breeding farms have been unable to sell their wool for the price they expected. Some of them continued to wait for a buyer three months after shearing. That is unprecedented in Kazakhstan or Kyrgyzstan where farmers try to sell their clip immediately after shearing. Mrs. Lushikhina agreed that the farmers need their wool professionally tested to generate objective data about their product. This would give them the opportunity to advertise wool to a wider community of buyers and increase their marketing options. They could price their wool based on objective information on quality as opposed to purely visual assessment.

Collecting samples from bales, Lushikhina farm, September 2005. Photo by Liba Brent.

Liba Brent collected grab samples from 319 bales at several farms in the Talas region including the state breeding farm by the name of Lushikhina (3,500 sheep) and seven surrounding farms (6,000 sheep). Brent also traveled to farms in the Issyk Kul region near the town of Karakol (5,000 sheep) and collected samples from 80 bales. The samples were analyzed at the ST Group Company lab using the OFDA 4000. The results were made available to the producers and wool buyers interested in purchasing the wool, and to the Sheep Breeding Department at the Kyrgyz Academy of Sciences.

The Lushikhina farm and the surrounding private farms collect sort, press and market wool together to generate economies of scale. In 2003 they sold their wool to Russia through a governmental company. After the government of President Akaev fell the officials involved in organizing the wool trade fled the country and the farms had to look for another buyer. In 2004 they sold their wool to an Indian buyer. In 2005 the buyer did not return and the farmers refused to sell their wool for $1 - $1.20/kg which was the market price in Kazakhstan and Kyrgyzstan in the spring of 2005. In September 2005 the farms had 40 tons of wool but were unable to get a price above $1.20 per kg. The directors of the farms were very interested in getting the wool tested and agreed to collect core samples from bales after shearing in the spring of 2006.

The Lushikhina farm benefited from receiving 200 ewes and about 47 Australian merino breeding rams through a project financed by the World Bank in 1995. Since then the farm has been trying to produce a merino breed of sheep with Australian wool. In the spring of 2005 the Kyrgyz government certified a new breed called the Kyrgyz High Mountain Merino. Although the breeding work on

Table 6. Kyrgyzstan, Talas and Isyyk Kul regions, grab samples from bales collected by Liba Brent.

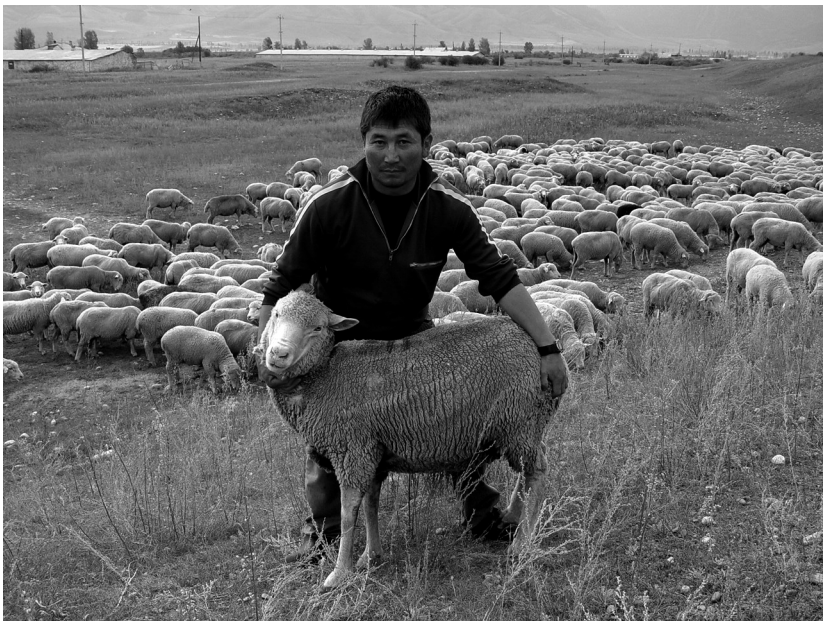
Farm	# of bales	Type of Wool	Fiber Diameter	SD	Comfort Factor
Lushikhina	8	70 - 1-2	22.9	5.5	91.6
Lushikhina	159	64 –1	24.6	6.1	83.3
Lushikhina	19	64 –2	24.66	6.1	75.78
Lushikhina	14	60 -1-2	25.3	6.9	79.1
Lushikhina	8	Tags/Bellies	23.98	6.8	85.71
Lushikhina	18	Base wool	24.26	6.7	84.133
Lushikhina	16	Discarded wool	25	6.6	80.6
Lushikhina	4	Medium wool	27.2	8.325	70.225
Belek	20	64-1	23.6	6.1	86.6
Amanbai	11	64-1	24.5	6.3	83.8
Azamat	2	Mix	24.94	5.75	83.85
Sartbek	11	64-1	25	5.9	83.3
Adit	5	64-1	25	6.46	81.32
Kainar	6	64-1	25.1	6.2	82.8
Abdaly	18	64-1	25.27	6.35	80.19
Zaria	77	Mix	25.1	6.7	80.6
Orgochor	3	Mix	24.7	6.7	82.6

the farm has been successful and the farm produces high quality wool, the wool prices have declined during the last decade and the farm has difficulty selling the wool for high prices. Moreover, the merino lambs require more care than the local fat rump coarse wool breeds and they sell for less on the market because they are smaller and the Kazakh and Kyrgyz consumers prefer the meat of the fat rump sheep. However, there is no demand for the coarse wool of the black-faced fat rump sheep and the fine white wool is an important source of cash for merino farmers in May or June when live animals are not ready for sale. Given that the Lushikhina farm and other merino breeding farms currently plan to continue producing merino sheep they are very interested in obtaining objective wool data that could help them advertise their wool on the international market.

The sampled farms in the Issyk Kul region included the Zaria cooperative farm at the Teplokluchenka village near the town of Karakol. The Zaria farm had about 10 tons of wool that was not sold due to the low prices in 2005. The sample collection at this farm showed that the wool was poorly sorted. Many bales contained merino wool mixed with coarse wool and hair which automatically lowers the value of the entire bale. The wool was also improperly baled using materials that contaminate wool. Brent discussed the problem with the chief zoo technician who agreed that the wool sorter does not work responsibly and allows the shepherds who take care of the farm's flocks bale in wool from their own animals that are not purebred. The zoo technician agreed that they needed to hire a new sorter and monitor the sorting and baling process during the 2006 wool season. The project also collected samples of wool produced at the surrounding farms that breed merino sheep and bale and market their wool through the cooperative to achieve economies of scales. The wool from the private farms went through the same baling and sorting process and was also contaminated. The Orgochor farm had relatively well sorted and baled wool. The team agreed to collaborate with the farms in the Issyk Kul

Table 7.Wool samples measured from 6 farms in Kyrgyzstan. Wool side samples collected and measured by KSBA.

Name of farmer	Fiber Diameter	SD	CV	Comfort factor
Mykyev Shaiyk	20.5	3.8	18.5	97.4
Saralaev Asranbek	21.5	4.6	21.6	95.6
Tynaliev Kasym	21.5	4.4	20.6	95.7
Alymkylov Bazarkyl	22.1	4.5	20.6	94.4
M Bokonbaev	23.2	4.5	19.2	92.1
Kachkarbaev Sizdbek	27.6	6.6	24.0	68.1



Kyrgyz merino sheep at the Zaria farm, September 2005. Photo by Liba Brent.

region on sample collection and wool sorting in the spring of 2006

Household surveys were completed and the project is in the process of identifying an Agricultural Economist to become a member of the project and who will also analyze the data from the 62 households. All data is complete but has not yet been analyzed.

A research project was initiated to evaluate the degree of variability in fiber diameter in 6 farmer's flocks. The average diameter ranged from 27.6 microns with a Coefficient of Variation of 24% to 20.5 microns with a CV of 18.5% (Table 7).

Activity 2: Training on fiber quality handling

Problem Statement and Approach. In order to supply high quality fiber to markets, Kazakhstan and Kyrgyzstan need to assist producers and buyers in sorting and classing wool and cashmere to improve quality and prices. Many wool producers and buyers lack training in preparing and sorting wool and in assessing wool quality. This lack of capacity results in a poor preparation of wool at the farm level, poor sorting at the collection points, unfair pricing of wools collected by middlemen buyers, and a low quality of wool in bales marketed to processors. The team focused on training wool sorters who then worked on farms during shearing and assisted farmers with proper wool sorting. Cashmere workshops focused on how to increase profit from selling fine fibers by getting farmers to sort their cashmere into grades and form village marketing cooperatives to sell in bulk at higher prices to large-scale buyers from Almaty.

Progress. Two cashmere training workshops were conducted for producers, local traders and government officials in Kyzl Orda region of Kazakhstan on how to increase value from selling raw cashmere. In April 2005, a two-day training workshop was conducted in Shieli district, neighboring to the west of Zhane Kurgan district. This extended the coverage of farmer training and information to two districts. A follow-up one-day workshop was also held in Zhane Kurgan, where a workshop was held in April 2004. This focused on getting farmers to sort their cashmere into grades and form village marketing cooperatives to sell in bulk at higher prices to large-scale buyers from Almaty.

Several capacity-building sessions were held between Hillary Redden, the UK cashmere consultant and staff of the Kazakh partner Mynaevo Institute Goat Department. The consultant explained and demonstrated the criteria for selecting high quality cashmere goats in their elite breeding program.

She conducted practical demonstrations with the staff. Selection in the elite flock will continue by culling those goats whose fiber does not meet the international cashmere standards.

Work is nearly completed on editing a second cashmere producer training video, using footage from the first farmer training workshop in 2004 and on how raw cashmere is processed from the Mongolian study tour. The second video is in Russian with English subtitles, since farmers in Kazakhstan, Kyrgyzstan and Tajikistan each have their own languages but Russian is common to all three countries. Host country project partners will present the video at training workshops in Kazakhstan and Kyrgyzstan in spring 2006. Copies will be distributed to district administrations and agricultural development projects (e.g. USAID AgFin+ and German GTZ Cashmere projects in Kyrgyzstan).

A two day training workshop was scheduled to be held in several regions of Kyrgyzstan. These two-day workshops were to cover management of animals and its relationship to contamination levels in wool. While these workshops were not conducted due to constraints imposed by Dr. Stobart's additional commitments, this material was covered during the shearing school. Two farmers from each of the regions were present and participated in the shearing school, as well as KSBA regional managers from these regions

A 2-day shearing school with emphasis on value adding was held in Kyrgyzstan, 10 farmers and 5 KSBA regional managers participated. In addition to learning the techniques of shearing, the participants also were provided information on animal management during the year to prevent foreign contamination schooled in management decisions that occur during shearing that keep the wool clean, instructed in sorting techniques to remove material that detracts from its value and establishing several lines of wool that is of similar diameter and fiber length.

Liba Brent, Murat Otynshiev and Serik Zeitenov organized a 10-day training of seven wool sorters at a wool collecting point in the Uzynagach village in May 2005, at the beginning of the wool season. Nina Kazyrackaia, a wool scientist from the Sheep-Breeding Institute, conducted the training. She taught seven men and women sorters how to sort different types of wool that was brought to the collection point by farmers and middlemen buyers. The training took place from May 20th to May 30th. After the training, the wool sorters worked at farms and collection points that sell wool to the STGroup Company which is the largest wool-buying and processing company in Kazakhstan. They assisted farmers with sorting wool during shearing to improve quality. Liba Brent observed the training process and visited some of the farms where sorting took place in June 2005.

Activity 3: Cost-benefit analysis of cooperative transport and marketing of fibers

Household surveys (n=50) from three villages in southern Kazakhstan included detail on herds, cultivation, sales and expenses.

A system dynamics modeling tool called Stella® was used to represent a typical livestock owner. Goat and sheep numbers were modeled for 50 years. Profits and expenses were modeled, including buying and selling animals, taxes, transport fees, and selling skins and fiber. Family labor costs were excluded. In experiments, goat fiber was increased from its sheared, unsorted value ($1.38/kg, or 182 tenge/kg) to $15/kg (1992 tenge/kg) for sale within villages of combed, sorted fiber, to $24/kg (3187 tenge/kg) for combed, sorted fiber sold at market. When combed, fiber per goat was reduced from 0.52 to 0.2 kg. Transport costs were zero when selling to local buyers, but were increased to $6 (804 tenge), based on data from other villages and the distances between farms and the Turkistan market. Distance was taken from high resolution satellite images. Analyses focused on goat fiber, for current shearing, combing sold locally, and sale at market.

Model Structure. Data allowed almost all parameters to be set explicitly. In the simulation of current conditions (i.e., 'Shearing'), the goat herd, numbers sold, bought, and slaughtered, fiber sales, etc. matched the data well, and were robust in sensitivity analyses. Net profit from the flock ($452/yr, 54 goats, 87 sheep) was consistent with earlier results.

Average fiber income rose from $38/yr to $173/yr when owners combed goats. Herd size rose as well, due to more animals purchased. When fiber was transported, $278/yr was sold. Net profit doubled when owners combed fiber, and rose further when fiber was transported to a large market. Expenses such as transport, fodder, and labor costs increased, but these were offset by higher sale prices.

Activity Four: Advanced Training and Advice on Wool and Specialty Fine Fibers

Problem Statement and Approach. In addition to the farm-level training component of Activity Four, the training of professionals in techniques of fiber quality assessment and the use of up-to-date technology is necessary to create sustainable marketing improvements. Research technicians and scientists need to learn how to effectively use new fiber assessment equipment to make informed decisions on selection criteria for improving breeds, learn about current testing methods and specifications as outlined by IWTO and/or ASTM and how to perform these methods in a laboratory setting. Interpretation of results will be stressed such that those attending the training session can utilize the information obtained, either by laboratory analysis or through state of the art fiber assessment instruments to disseminate this information to the research community, farmers and to the processors. Students will learn how processors utilize the information they are obtaining in the laboratory and why the technical specifications demanded by the processors is based upon those data reported by testing laboratories. Under this activity, a five day training course was provided to five Central Asian fiber technicians/research scientists at Yocom-McColl Testing Laboratory Inc, located in Denver Colorado. Yocom McColl is the only commercial wool testing facility in the United States and would be an excellent model to emulate to set up testing facilities in Central Asia. This training will connect integrally with Activity 2, Training on Fiber Quality Handling at Farm Level. The course curriculum was as follows:

1.) Fiber sampling and metrology: includes practical training in all aspects of fiber sampling, sub-sampling and measuring of staple length, staple strength, yield, and fiber diameter.

2.) Processing and end-uses of animal fibers.

Progress. Three people from Kyrgyzstan and two from Kazakhstan attended the fiber training session held at Yocom-McColl Testing Labs Inc,

Two of the Kyrgyz participants in the advanced fiber training workshop held in Denver Colorado, Mr. Urmatbek Akmyrzaevich and Mr. Kamchybek Tursunalievich shown with Mr. George Salisbury, a long time sheep and cattle rancher from Savery, Wyoming. Photo by Bob Stobart.

Denver Colorado. The participants were exposed to everything related to a commercial fiber testing lab. They had the opportunity to do actual hands on activities related to clean fiber determination, measuring fiber diameters by projection microscope, OFDA100 and Laserscan, running staple strength and staple length tests. The overall concept of the importance of sampling, both from bales of wool for yield and diameter testing to individual animals was stressed throughout the workshop. How a commercial lab operates was also presented and how important confidentiality, accuracy and timeliness were in establishing credibility with commercial customers as well as farmers and traders. These participants were provided with the knowledge of modern, up-to-date testing techniques, advanced fiber measuring instruments and the ability to interpret results that would be beneficial to the scientific community and farmers both in the research and marketing of wool and other fiber's.

Gender

Kazak and Kyrgyz women, in common with women in other parts of Central Asia, have traditionally processed livestock fiber products from sheep, goats and camels into homemade articles such as carpets and clothing. Sometimes these articles are sold by women and provide a much-needed source of cash income. In handling wools and fibers, women comb, clean, sort, card, spin, weave and knit, as well as make felt and knotted carpets. When male household heads were interviewed about production and sales of wool and other fibers, they frequently referred to their wives for accurate information, which rarely occurs in the case of other household livestock management questions. Central Asian women are knowledgeable about and interested in wool and animal fibers, and should therefore be a focus of development efforts to improve marketability of these commodities.

The flocks of sheep and goats in the households we have worked with are generally in the hands of men. However, women do a lot of the work of milking and food processing. It might be hypothesized that if cashmere combing becomes more prevalent, it might have a negative affect on women's time; however, if incomes are greatly increased the women might not mind the added work. We will monitor this in the assessments of the 2004 farmer training workshop (Activity 1). We know from fieldwork Galvin conducted in July 2004 that camel herders do not separate coarse from fine camel hair because they say it is too time consuming. The only condition under which it occurs is when women want the fine hair for home use (usually in blanket making).

Liba Brent works with groups of Kyrgyz and Kazakh women who produce felt clothing and other items for export. These groups have difficulties with obtaining quality fiber and are interested in purchasing fine wool from small farmers in Kyrgyzstan and Kazakhstan. Brent plans to work on developing new market networks that will link groups of women felt producers and fine wool producers in both countries. She wrote a project proposal "How to Develop Market Linkages between Small Wool Producers and Processors" for which she currently seeks funding.

Policy

The joint GL-CRSP and Macaulay Institute meeting in Almaty was attended by the following donors: USAID, Canadian CIDA, British Embassy and DFID, World Bank, Winrock International (USAID Farmer to Farmer) and Israeli International Aid Organization, MASHAV. Six members of the GL-CRSP team made presentations and the project video was shown: "From Goat to Sweater: Training and information for Kazak farmers". Follow-up meetings were held between project team members and USAID Central Asia, British Embassy and UK Dept. for International Development (DFID), Farmer-to-Farmer program and the World Bank representative.

The project has been able to raise donor attention to the potential for cashmere market development in Central Asia. USAID Central Asia is now aware of the potential for cashmere to improve rural livelihoods – especially among the poorest and most remote farmers - in Kyrgyzstan and Kazakhstan. As a result, USAID is now outlining plans for new regional projects and training on cashmere. The USAID Farmer-to-Farmer program is designing

projects on cashmere farmer training and market development in Kazakhstan and Kyrgyzstan, as a result of meetings in which GL-CRSP project results were conveyed.

The World Bank rural development office in Kazakhstan has noted that cashmere is an important commodity for the livestock sector in Kazakhstan. The new WB project with the Kazakh government on Agricultural Competitiveness, starting in 2005, contains funding for activities on developing standards laboratories and private investments into agro-processing that would include cashmere. Discussions are on-going about applying for this funding support.

From the host governments' side, Kazakhstan regional officials in the target areas have expressed considerable enthusiasm in developing markets for farmers' cashmere sales. The Shieli district governor emphasized that Kazakhstan's President has charged local government staff with finding ways to improve the livelihoods of poorer farmers, and that selling cashmere was especially relevant for poorer livestock owners who are concentrating on keeping goats. This is in line with the Kazakh government's new policy, frequently stated by the country's President, of promoting investment into agro-processing and increasing value-added exports of agricultural commodities.

In Kyrgyzstan, the head of the livestock department in the Ministry of Agriculture participated in the Mongolian cashmere study tour, and has indicated that cashmere is a high priority in developing Kyrgyzstan's livestock sector. He stated that "cashmere production is increasing in Kyrgyzstan; one kg of cashmere is being sold by farmers for $12-15 kg and developing markets would be a good investment for improving the lives of Kyrgyz farmers". He commented that it was necessary to assess the cashmere produced by Kyrgyz goats to check if this meets international processors' demands. He felt that the priorities for market development were: 1) farmer training and 2) mass media price information, as a lot of farmers did not know what was happening with cashmere market demands.

During 2004 in Kyrgyzstan, the official export value of cashmere (whole fleece and combed down) was 1.26 million dollars for a total of 855 tonnes. Similar export data for Kazakhstan are not available. However, it is recognized that much cashmere leaves the country unofficially for China and is therefore not recorded. Combed down exports from Kyrgyzstan were valued at $4,450 per tonne or $4.5 per kg. Information provided by Kasiet, the main domestic wool consumer/processor in Kyrgyzstan indicated that Kyrgyzstan produced approximately 10,000 tons of wool in 2004, of which fine wool accounted for approximately 2000 tons. The value of the fine wool was approximately $2 million dollars. If the remaining 8,000 tons sold for $0.50/kg, that would return approximately $3.6 million dollars, so total wool income would approximate $5.6 million.

Host country partners. The plans for Year 3 on cashmere market development were discussed in detail with the national Kazakh research partners. They stated that Year 3 project priorities on cashmere should be:

- Supporting the elite breeding flock managed by Mynbaevo Institute to allow distribution of superior genetic material to farmers
- More activity on finding profitable new markets for cashmere exports
- Seeking investors for setting up cashmere processing within the country.

The research partners noted that farmer training workshops over the first two years have been successful and can probably be financed in future from the Ministry of Agriculture budget allocation to the Mynbaevo Institute. The Ministry no longer finances animal breeding research on-station, but supports on-farm practical work.

In Kyrgyzstan, the two UK cashmere consultants had discussions on cashmere market development with USAID Central Asian officers and project staff (Country Director for Kyrgyzstan, Agriculture, Rural Development, Agricultural Finance project, Fergana Valley project). A one-day cashmere training workshop for farmers and agricultural project staff was held in Osh, southern Kyrgyzstan, organized by the Agricultural Finance project (Winrock/ USAID).

The study tour to Mongolia introduced

the system of Mongolian cashmere production, marketing, processing and export to a group of Kyrgyz and Kazaks with a special interest in developing a cashmere sub-sector in their own countries.

Participants represented four sectors: government policy, livestock research, commerce and farmers' associations[1].

The Wisconsin team members informed policy makers (i.e. local officials responsible for monitoring and assisting the sheep industry) about project activities in the pilot regions. The policy-makers showed interest in the project and support for our efforts to promote wool market development. They pointed towards the lack of governmental funding of the sheep industry, which prevented them from assisting sheep farmers in production and marketing. Our collaborator, Murat Otynshiev, works for a governmental organization that seeks to develop a marketing infrastructure for different kinds of agricultural production, including wool. He has good connections to policy makers and will continue to inform them about our research and its policy implications.

The policy environment for market development of livestock products is changing, as national decision-makers have again recognized the economic contribution of these products to their countries. In Kazakhstan, the government has recently opted to take a majority share-holding in the larger privatized wool processing and trading companies. The government therefore has a stake in the continued expansion and profitability of these markets. Results from the project's activities of providing training materials for producers as well as testing interest in market information centers and pools will also feed lessons learned into a current project by USAID/ Almaty which is piloting farm extension centers in other regions of Kazakhstan.

In Kyrgyzstan the development of KSBA has been a major strategic choice by government and the government has borrowed $12 million to date for development of the sheep sector. Current development priorities stress the agricultural sector, and the new Poverty Reduction Strategy Paper stresses livestock development. The KSBA may well provide a model for institutional development of livestock producer organization's which would be relevant also for Kazakhstan, where such organizations have not yet appeared.

Outreach

Farmers are identified as the primary stakeholders to whom we are targeting in this project. Activities described already, workshops, training sessions etc. are the means by which the goals of the project are being fulfilled. Farmers in the Dzhambul, Aksui and Raimbek districts, Kazakhstan and the Chui and Talas provinces in Kyrgyzstan had training sessions on wool sample testing and improvements in wool production and marketing. The farmers learned about the quality of the wool they produce, about wool marketing in countries such as the United States, about the needs of wool processors for sorted, quality wool and about wool prices and quality standards of the international market. This information will help producers and buyers to make better production and marketing decisions and to identify their stakes in improving the local marketing system to increase their income from wool production.

A two-day farmer-training workshop on cashmere was conducted in the project area of Zhane Kurgan district center, Kazakhstan. Seventy participants from ten villages attended. The video film "From Goat to Sweater" was shown at the workshop. Other training materials included diagrams on the price variation of raw cashmere by quality, samples of different quality cashmere, which were distributed to workshop participants, and diagrams on how farmers can improve cashmere quality through breeding. Hands-on demonstrations with participants showed how to comb and grade cashmere.

Developmental Impact

Environmental impact and relevance. Though the project objectives do not directly address this question, it has become clear that market development needs to reflect regional ecological variations in the region. Both countries span major climatic and topographic regions with resulting agro-ecological zones. During and before the Soviet period,

different breeds of livestock species were adapted to the particular physical conditions of each zone. Thus in the extensive deserts of southern Kazakhstan, the Karakul sheep and local breed of goat thrived in the past and continue to be the mainstay of livelihoods. In the better-watered mountain foothills and valleys of Kyrgyzstan and southern Kazakhstan, cross-bred Merino fine wool sheep were introduced to the Soviet state farms. Some of these are still retained though many are now crossed with local meat-type sheep breeds.

Agricultural sustainability. This project examines how livestock resources can be better exploited to meet new commercial demand as well as increase economic returns to producers. The results of this study will be of interest to two livestock development projects in Kyrgyzstan -- the World Bank sheep development project and the new UK DFID project "Support to livelihoods in livestock producing communities." The USAID Mission does not presently fund livestock-focused projects in either country. Kazakhstan does not have any livestock development projects, despite the importance of rangelands as a national resource, the tradition of extensive livestock rearing and the contribution of livestock to rural household economies. This project proposes measures for assisting producers, researchers and the commercial sector to realize greater value from wools and fibers through the market. These measures could be implemented through government and donor-assisted projects in the future.

Contributions to U.S. agriculture. Information from this project could be used to determine to what extent the U.S. small stock, wool and cashmere industry (to the extent that they exist) could become interested in Central Asian livestock products and contribute to the Central Asian breeding stock.

The project will contribute to increasing demand for U.S. technical expertise in this area, improving sources of raw material availability for U.S. wool and cashmere importers, increasing the potential of equipment sales by U.S. manufacturers of sheep, wool, goat and cashmere equipment and services, generating training opportunities and long term contacts among institutions, and promoting private sector relationships for wool and fiber testing facilities in the U.S. The project fits well within USAID priorities for the region and the academic strengths of the research institutions involved.

Contributions to Host Countries. The case of Mongolia demonstrates the possible benefits to the host countries of developing a successful wool and fiber market. Selling raw cashmere has become the major source of income for privatized herders in Mongolia and Mongolia's raw cashmere production has risen by 70% propelled by a strong demand from China, USA and Europe. The Mongolian government has encouraged direct foreign investment and new technology.

The project will strengthen the international competitiveness of Central Asian wools and fibers by improving national fiber assessment capabilities and specialist training, strengthening market information flows between producers and a broader global commercial sector, and increasing producers' ability to offer higher quality products in demand from international markets. Marketing wools and fibers that are more attractive to buyers will have direct development relevance for producers who can expect to receive better prices and larger volume sales for their products, improving incomes. Each additional export of wool and fiber has a positive development impact on national accounts and contributes to increasing agricultural productivity. The project will contribute to resource sustainability through its policy focus on the spatial analysis of markets and the resource base in surrounding producer regions.

Linkages and networking. We work closely with Macaulay Institute.

Other Contributions

Support for free markets and broad-based economic growth (i.e., agribusiness and private enterprise). For the past decade in Kazakhstan and Kyrgyzstan pastoralists have been disengaging from the state collective farms and establishing contact with new domestic markets for livestock. One of the most pressing questions for the future of the livestock industry in both countries is whether small flock owners will have the resources to continue as livestock keepers. Ecological location and market access are also crucial to the success of livestock enterprises in both countries.

Contributions to and compliance with mission objectives. In so far as the mission is concerned with increasing the livelihood strategies of Central Asian households, this project goes a long way towards addressing how this might be done.

Concern for individuals. Throughout this project we have been concerned about individuals and households ability to increase their economic base.

Support for democracy. The fact that the peoples of Kazakhstan and Kyrgyzstan have to engage in the open market will enhance their interaction with market economies. This may have a positive impact on the movement toward democratic government.

Humanitarian assistance. Not applicable.

Leveraged Funds and Linked Projects:

KSBA will contribute the equivalent of $5,000 in the provision of facilities and research staff. Unlike matching funds, the KSBA contribution is considered unofficial and non-auditable. Malcolm Childress will provide consultation and back-up on project management and specific activities from Washington, DC and in the field in Kyrgyzstan, Kazakhstan and Tajikistan. He will contribute $6,000 as in-kind matching (12 days consulting, $500/day), the consulting days will come from his vacation days, and has no connection to his employment at the World Bank.

The value of leveraged funding for WOOL was USD $37,705.

NSF DEB-0119618, Biocomplexity, Spatial Scale, and Fragmentation: Implications for Arid and Semi-arid Ecosystems (SCALE), N.T. Hobbs-PI. Project dates: 10/01-09/06, $1,800.

USAID Central Asia Regional Training Program Academy for Educational Development "START" project, C. Kerven-PI. Project dates: 04/05 $6,000.

British Embassy & UK Dept. International Development, Mongolia Study Tour. C. Kerven-PI. Project dates: 06/05, $20,000.

USAID Central Asia Regional Training Program Mongolia Study Tour with C. Kerven-PI. Project dates: 06/05, $2,500.

Macaulay Institute UK, Kazakhstan local transport and accommodation, C. Kerven-PI, 10/04, $1,500.

Aga Khan Foundation Geneva, Kazakhstan airfare, London-Almaty, C. Kerven-PI, 09/04-10/04, $1,167.

USAID Central Asia Regional Training Program, GL-CRSP and IGC meeting, financed Akylbek Rakeav attendance. R. Stobart-PI, 6/05, $3,098.

ST-Group, Train wool graders and sorters, L. Brent-PI, 5/05, $1,640.

Training

Shearing School and Wool Handling and Preparation Workshop. Purpose: to present current techniques in handling wool at shearing that will add value to the fleece, ie, remove some portions due to defects, added matter etc. Addresses problems that processors have to deal with that economically affect the value of the raw product. June 5th and 6th, 2005 in Bishkek, Chui Oblast. Facilitated by Stobart and Rakaev. Attended by 17 participants (16 male and 1 female).

Training in Wool Sorting and Classing. May 20 - May 30, 2005 in Wool collection point, Uzynagach village. Facilitated by Nina Kazyrackaia, Sheep Breeding Institute. Attended by 7 participants (4 male and 3 female).

Wool Sorting and Handling Clinics. Training in wool sorting and handling during and after shearing. May - June 2005 in Raimbek, Aksui & Dzhambul regions of Kazakhstan. Facilitated by Murat Otynshliiev, Elipaeva, Saginbaeva, Seimbekov, Basilov, Nurmagametova. Attended by 12 participants (7 male and 5 female).

Adding value to grease wool at the farm level. Educating farmers on how to sort their cashmere into grades to sell at higher prices. Spring 2005 in Chui, Talas, Naryn Oblasts. Facilitated by Stobart and Rakaev.

Shieli Training Workshop. Two-day workshop and demonstration on combing goats to gather cashmere and cashmere marketing. April 11, 2005 in Shieli, Kyzl Orda Region, Kazakhstan. Facilitated by Hillary Reddin, Carol Kerven, Serik

Aryngaziev. Attended by 45 participants (42 male and 3 female).

Zhanekurgan Training Workshop. One-day workshop and demonstration on combing goats to gather cashmere and cashmere marketing. April 16, 2005 in Zhanekurgan, Kyzl Orda Region, Kazakhstan. Facilitated by Hillary Reddin, Carol Kerven, Serik Aryngaziev. Attended by 44 participants (42 make and 2 female).

Osh Training Workshop. Training workshop on cashmere gathering and marketing. April 21, 2005 in Osh, Kyrgyzstan. Facilitated by Carol Kerven, Hillary Redden. Attended by 17 participants (15 male and 2 female).

Wool Fiber Training. Workshop on Wool Fiber analysis. Sept. 10-19, 2005 in Denver, Colorado. Facilitated by Bob Stobart. Attended by 9 participants (8 male and 1 female).

Collaborating Personnel

Kazakhstan

Aryngaziev, Serik. Mynbaevo Sheep Breeding Institute, Animal Science, Scientist.

Arnygaziev, Berik. Mynbaevo Sheep Breeding Institute, Animal Science, Scientist.

Kasymov, Mausimbaevich. Mynbaevo Sheep Breeding Institute, Sheep Breeding, Ph.D., Researcher.

Karymsakov, Koishibek. Mynbaevo Sheep Breeding Institute, Director of Wool Laboratory, Ph.D., Researcher.

Malmakov, Nurlan. Institute of Livestock & Vet Research, Animal Science, Researcher.

Nusupbekovich, Abil. ST-Group, Sheep Brd. and Wool Expert, Ph.D., Researcher.

Otynshiev, Murat. ST-Group, Wool Expert, Researcher.

Smailov, Aidos. Independent consultant, Language, Interpreter.

Kyrgyzstan

Rakaev, Akylbek. Kyrgyz Sheep Breeders Assoc, General Director (1/2 time), General Director

United Kingdom

Kerven, Carol. Independent consultant, Anthropology, PhD.

United States

Brent, Liba. University of Wisconsin-Madison, Sociology, PhD, Post Doc.

Boone, Randall. Colorado State University, Wildlife Biology, Ph.D., Scientist.

Childress, Malcolm. World Bank, Agricultural Economist, Ph.D.

Galvin, Kathleen. Colorado State University. Anthropology, PhD, Professor.

Reed, Jess. University of Wisconsin-Madison, Animal Science, Ph.D., Professor.

Stobart, Robert. University of Wyoming, Animal Science, Ph.D., Professor.

Sunderland, Jennifer. Colorado State University. Animal Science, MA, Research Assoc.

Thomas, Dave. University of Wisconsin-Madison, Animal Science, Ph.D., Professor.

Collaborating Institutions

United States

University of Wyoming
Department of Animal Science
Dept 3684
1000 E University Ave
Laramie, WY 82071
Phone: 307-766-5212
Fax: 307-766-2355

Colorado State University
National Resource Ecology Lab
1499 Campus Delivery
Fort Collins, CO 80523-1499
Phone: 970-491-5784
Fax: 970-491-7597

University of Wisconsin
College of Agricultural and Life Sciences
Animal Science
256 Animal Science Bldg
1675 Observatory Dr.
Madison, WI 53706

Kazakhstan

Kazakh Research Technological Institute
of Sheep Breeding,
Mynbaevo Village, Dzhambul Raion
Almaty, Kazakhstan 483174

ST Group Company
Dostyk Street 89/2-9
Almaty, Kazakhstan 483174

Kyrgyzstan

Kyrgyz Sheep Breeders Association
Profsoyuznaya Str. 43
Bishkek, Kyrgyz Republic 7720080

Kyrgyz Livestock Research Institute
Frunze Village, Sokuluksky Raion
Chui Oblast, Kyrgyz Republic 722125

Publications

Boone, R.B. and K.A. Galvin. 2005. Factors related to marketing success for fiber producers in Middle Asia. Poster for the XX International Grassland Congress, Dublin July 2005 and paper published in: O'Mara, F.P., Wilkins R.J., 't Mannetje, L., Lovett, D.K., Rogers, P.A.M., and Boland, T.M. (eds.) XX International Grassland Congress Offered papers, page 841, Wageningen Academic Publishers, The Netherlands.

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Kerven, C., S. Aryngaziev, N. Malmakov, H. Redden, A. Smailov. 2005. Cashmere marketing: A new income source for Central Asian livestock farmers. GL-CRSP Research Brief 05-1-WOOL, April.

Kerven, C. 2005. Selling cashmere brings income for Central Asian pastoralists. GL-CRSP Newsletter Ruminations. Spring.

Kerven, C. 2005. Cashmere can bring income for Kazakh livestock owners [in Russian]. British Embassy Quarterly Newsletter, Almaty, Spring.

Smailov, A. and Kerven, C. 2005. Local goats can make profits for farmers. [In Russian and Kazakh] Agro Inform journal, Ministry of Agriculture, Republic of Kazakhstan, Almaty, May.

Footnotes

[1]One of the Kyrgyz participants reported as follows:

"Thanks to the experience gained during the study tour I can say with confidence that I am ready to help Kyrgyz farmers with their selection, combing, sorting and marketing of raw material. If we produce high quality cashmere in the long term then Mongolian processors are ready to buy cashmere in Kyrgyzstan.

By applying the existing knowledge and new experience gained during the study tour in Mongolia

I believe we could contribute by putting all our efforts into development and promotion of the cashmere industry in Kyrgyzstan and into alleviation of poverty in rural areas in particular, the poverty among shepherds and goat-breeders.

To introduce cashmere production in Kyrgyzstan we will need the assistance and support of foreign investors and projects. As Kyrgyzstan is truly on its way to democratization, foreign aid and assistance is needed."

[2] Source: Lecraw, D. 2005 Mongolian cashmere industry: Value chain analysis. Unpublished report, Gobi Initiative, Mercy Corps, Ulan Bataar.

[3]The Southern Kazakh Merino is one of four merino breeds developed in Kazakhstan. The others three are the Northern Kazakh Merino, Kazakh Fine wool and the Arkhar Merino.

[4]The formal status of a cooperative does not imply that the members or shareholders have any say in the farm's management or the distribution of profits. The director of a cooperative farm has as a rule the ultimate decision-making power. Many directors treat the farm's assets as personal property and the workers as hired labor.

[5]The company produces tops and yarn in the Tokmok factory in Bishkek and sell it to Turkey and Spain.

Lead Principal Investigator

Robert Stobart, Professor, University of Wyoming, Department of Animal Science, Dept 3684, 1000 E University Ave. Laramie, WY 82071. Phone: 307-766-5212; Fax: 307-766-2355. Email: bstobart@uwyo.edu.

Assessment Team: Managing National Parks in the Context of Changing Populations and Economies

Narrative Summary

We received funding from the Global Livestock Collaborative Research Support Program (GL-CRSP) to fund an extension of our planning activities for the first six months of 2005 for the purpose of enhancing the capacity for analyzing and supplying tools and information that integrate reliable, scientific knowledge on ecosystem dynamics and indicators of human well being into decision-making processes as they affect the sustainability of both the Greater Serengeti-Mara and Yellowstone ecosystems.

We accomplished the following:

1) We convened a workshop in Yellowstone in February 2005 to develop case studies regarding the maintenance and enhancement of migration corridors in land-use change hot spots in which findings from each ecosystem function as one tool to explore policy alternatives;

2) We convened a meeting of the project Management and Science Committee in February 2005 to refine project objectives and to develop policies and protocols for ongoing collaboration and to produce a written proposal and plan for future collaboration;

3) We sponsored travel by Yellowstone, Serengeti and Mara collaborators to the GL CRSP Program Conference in Dublin in July 2005 during which time we further developed our proposal by developing a policy analysis focus in collaboration with Dr. Tim Clark of Yale University;

4) We submitted a proposal to the GL-CRSP in June 2005 in which we proposed a strategy to address interrelated substantive and procedural problems stemming from challenges in integrating people, wildlife, and livestock in landscapes undergoing rapid social, economic, and demographic changes.

Research

Problem Statement and Approach. The Yellowstone and Serengeti-Mara are two of the world's largest and ecologically intact ecosystems. The geographic extent of the two systems are defined in several ways, including the migratory movements of large herds (e.g., wildebeest, elephants, elk, antelope) that move outside the Parks' protected areas seasonally. Outside the Parks, wildlife migrations traverse a matrix of public and private lands that are managed for widely different purposes. In both systems, a diverse set of management authorities — federal, state and local government entities, along with individuals and associations, with an equally diverse set of goals manage land and/or resources outside the Parks. In the Greater Yellowstone, this has led to a "dense, highly fragmented and complex policy arena (Table 1). Similarly, in the Serengeti-Mara ecosystem land tenure and management policies are similarly complex, compounded by the international border bisecting the ecosystem.

In our deliberations and analyses during and subsequent to the February 2005 Workshop, we worked together to identify common issues shared by the GYE and GSME that would warrant a deeper, collaborative policy analysis.

Progress

YESEMA collaborators worked to refine a policy analysis (sensu Clark 2002) framework for our ongoing collaboration. Using this framework, institutional complexity and rapid social, economic and demographic changes in the GYE and GSME combine to create a situation where the capacity and flexibility of existing management policy systems responsible for effective resource management

Table 1.

Entity	Policy/mission	Tenure
Serengeti (Tanzania):		
Serengeti National Park	Wildlife tourism and conservation	Federal
Ngorongoro Conservation Area	Wildlife tourism and conservation; local land use restricted to herding and small scale farming	Federal
Loliondo Game Controlled Area	Herding, small-scale farming, wildlife tourism, hunting leases, mechanized commercial farming	Federal; villages hold title to the land; some private land
Maswa Game Reserve	Wildlife tourism, hunting leases	Federal
Ikorongo Game Reserve	Wildlife tourism, hunting leases	Federal
Grumeti Game Reserve	Wildlife tourism, hunting leases	Federal
Tanzanian Wildlife Research Institute	Manages all wildlife in Tanzania	Federal
Mara (Kenya):		
Masai Mara National Reserve	Wildlife tourism, hunting leases	County Council Trust
Inner Group Ranches (Siana, Kolyaki, Ol Choro Oirua)	Multiple land uses: herding, farming, wildlife tourism	Private plots, some areas are communal property (in trust)
Outer Group Ranches (Lemek, Nkorinkori, others)	Multiple land uses: mechanized commercial farming, small holder farming, herding, some wildlife tourism	Privately owned
Yellowstone (USA):		
Yellowstone National Park	Conservation of nature	Federal
Grand Teton National Park	Conservation of nature	Federal
US Forest Service (seven national forests in three regions)	Multiple use: timber, recreation, wildlife, mining	Federal
Bureau of Land Management	Multiple use: timber, recreation, wildlife, mining	Federal
US Fish and Wildlife Service	Migratory bird species, Threatened & Endangered species, Federal Refuges, Livestock Depredation	Federal
Montana Fish, Wildlife and Parks	Conservation of fish, wildlife, cultural resources. Law enforcement; outreach	State
Idaho Department of Fish and Game	Conservation of fish and wildlife, law enforcement	State
Wyoming Department of Game and Fish	Conservation of fish and wildlife, law enforcement	State

decision-making is increasingly overtaxed. Project participants agreed that the ongoing focus of the project should be on wildlife-livestock interactions as a window into the effectiveness of resource management policies. This is a particularly effective venue for collaboration because in the GYE and GSME, effective management of all resources, but particularly wildlife and its relationship to livestock, is increasingly jeopardized by human social dynamics, institutional complexity, and other forces and factors (e.g., parks and reserves as well as working ranchlands). The experience of the YESEMA project collaborators up to this point in time confirms the more general recognition that this complexity severely limits timely and effective management decision-making. This in turn is leading to degradation of the ecological function of the entire ecosystem and ability of the region to

sustain people and wildlife.

Together we developed a proposal for ongoing work with the goal of contributing substantially to the resolution of actual management issues arising from wildlife-livestock-human interactions. We proposed an "active learning" project that: 1) further refines our leadership team so that it functions effectively to oversee, direct, and manage the project as it evolves; and 2) uses proven methods to address complexly interrelated substantive and procedural problems stemming from challenges inherent in integrating people, wildlife, and livestock in landscapes undergoing rapid social, economic, and demographic changes. Methods include: (1) developing case studies of best management practices, (2) implementing and learning from prototype interventions to improve management, and (3) enhancing the "capacity" (i.e., knowledge and skills) of people at various levels and in targeted communities, including high-level resource managers, administrators, and policy makers through workshops, joint study tours, policy discourses, and other focused activities.

Gender

In our Workshop and subsequent activity we started to explore the potential ways in which gender and culture intersect to influence the way in which people, wildlife, and livestock interact as a component of the long-term sustainability of the greater ecosystems. We made plans and initial contacts to ensure that the ongoing proposed work would be inclusive of diversity in participants, perspectives (identities, expectations, and demands), as well as values. We developed two specific proposal elements to address gender issues. First, laid plans to ensure that relevant gender-based perspectives are represented in the group activities such as seminars and working groups. Second, in activities related to case studies and prototyping of policy interventions, we developed strategies to conduct literature surveys to assess the state of knowledge of gender-related issues associated with a particular case study or prototype. We proposed to develop a network of regional experts to guide us in this aspect of the project (e.g., the Maasai Women Development Organization (MWDO) and Tanzania Gender Networking Programme (TGNP)). Given the YESEMA Project's focus on management complexity in the face of rapid social and economic change, we proposed to perform rapid assessment (e.g., focus groups) if the available literature is dated and not reflective of current gender relationships as they relate to the topic at hand.

Policy

Policy makers in the form of park and natural area managers have been involved in the development of the YESEMA conceptual framework and proposal for ongoing work as participants and reviewers. These policy makers include:

- Yellowstone National Park: Dr. Glenn Plumb (Supervisory Wildlife Biologist), Mr. John Varley (Director, Yellowstone Center for Resources)
- Montana Fish, Wildlife and Parks: Mr. Kurt Alt (Regional Wildlife Biologist), Mr. Pat Flowers (Regional Director)
- Serengeti National Park: Mr. Justin Hando (Chief Park Warden)
- Tanzania National Parks: Dr. Emmanuel Gereta (Special Assistant to the Director), Mr. Edward Kishe (Director, Environmental Inventory and Monitoring)
- Tanzanian Wildlife Research Institute: Mr. Charles Mlingwa (Director General)
- Masai Mara National Reserve: Mr. Michael Koikai (Chief Park Warden); Mr. Samson Lenjirr (Chief Biologist)
- Group Ranches in Narok and Trans Mara Districts (Mr. Paul Montet and Mr. Patrick Ole Ntutu, community leaders)

Our contribution to policy development to date has been 1) opening a dialogue between researchers and managers that served to enhance the effectiveness of researchers in defining management-relevant science objectives and communicating results; 2) building trust between researchers and managers by reflecting on differences in values, perspectives, and cultures; and 3) opening up a dialog between the different land management entities (e.g., Yellowstone

National Park and Montana Fish Wildlife and Parks) in a neutral environment where the overarching GLCRSP objectives served to facilitate new understanding of the problem model.

Development Impacts

Environmental impact and agricultural sustainability. We contributed to increasing our understanding of Yellowstone National Park management issues that transcend jurisdictional boundaries (e.g., land use change, wildlife-domestic animal disease transmission) that affect livestock production on the lands outside the Park.

Contributions to host country. We worked to enhance the capacity for collaboration between Kenyan, Tanzanian and North American researchers on research issues of relevance to wildlife conservation in the context of regional economic development. In addition we increased the understanding of Serengeti National Park issues that transcend jurisdictional boundaries (e.g., wildlife-domestic animal disease transmission, opportunity costs of biodiversity conservation)

Linkages and networking. We enhanced the capacity for collaboration between regional land grant universities, federal and state agency-based scientists, east Africa-based researchers and Yellowstone National Park on policy-relevant research questions.

Other Contributions:

Support for free markets. By design, our project did not contribute directly to the support for free markets.

Contributions to mission objectives. Our project contributed to the mission objectives of maximizing the sustainable use of natural resources by working with communities and enhancing the effectiveness of local and national government entities charged with wildlife management.

Concern for individuals. Our project enhances individual livelihoods because for human rights to reach their full expression, natural environments must be secured and managed in sustainable ways so that people live in clean, healthy environments full of functioning ecosystems and rich in the diversity of living forms.

Support for democracy. Our project supports democracy be enhancing the capacity of land management institutions to devise and implement transparent, robust and credible management decisions.

Humanitarian assistance. Our proposed ongoing work contributes to humanitarian assistance by developing strategies to define benefits to communities associated with wildlife management in the context of livestock management.

Collaborating Institutions and Personnel

Lisa Graumlich, Lead Principal Investigator, Big Sky Institute, Montana State University.

Glenn Plumb, Yellowstone National Park, Wyoming, 82190, USA, phone: (307) 344-2225, fax: 307 344 2211.

Kurt Alt, Montana Fish, Wildlife and Parks, 1400 South 19th Ave, Bozeman, Montana 59717 USA, phone: 406-994-6935, fax: 406-994-4090.

Emmanuel Gereta, Tanzania National Parks, PO Box 3134 Arusha Tanzania, phone: 057-3471.; fax: 057-8216/4075.

Samson Lenjirr, Masai Mara National Reserve, P O Box 60, Narok – Kenya, phone and fax: +254-2-305-22068/22337.

Robin Reid and Mr. Ole Kamauro, International Livestock Research Institute, PO Box 30709. Nairobi, Kenya. Phone: 254-20-422-3000. Fax: 254-20-422-3001.

Tim W. Clark, Yale University, School of Forestry & Environmental Studies, 301 Prospect Street, New Haven, CT 06511, USA, ph: 203-432-6965, fax: 203-432-3817.

Lead Principal Investigator

Lisa Graumlich, Director, Big Sky Institute, Montana State University, Bozeman, MT 59717. Tel: (406) 994-5320; Fax: 406-994-5122. Email: lisa@montana.edu.

Assessment Team: Increasing Animal Source Foods in Diets of HIV-infected Kenyan Women and their Children: Can Treatment Outcomes be Enhanced?

Narrative Summary

The HIV & AIDS nutrition and agriculture project is focused on the effect of increased amounts of animal source foods in the diets of HIV-infected Kenyan women and their children. Preliminary evidence suggests that improved nutrition early in HIV may delay disease progression and delay initiation or improve the effectiveness of antiretroviral drug therapy.[1-4] In particular, animal source foods (ASF) such as meat, milk and eggs provide nutrients in utilizable forms that support the body's ability to maintain lean tissue, immune function, and daily activities. A high prevalence of HIV and AIDS in rural communities superimposed on existing poverty, erodes family and community infrastructure, exacerbates food scarcity and undermines the ability of rural Kenyan communities to eliminate poverty and attain self-sufficiency. The overall goal of this research is to determine if there is a "right mix" of food in both quantity and quality that will protect the immune system and prevent severe infection, prevent the loss of body mass and enhance the quality of life among HIV-infected Kenyan women who are not yet experiencing metabolic inefficiencies associated with the disease. These women may then be able to sustain themselves and their families with increased agricultural productivity.[5]

The assessment team project resulted in a full project proposal. The objectives of the proposed project are:

1) to determine if ASF added to local diets have a significant effect on the overall health and progression of disease in HIV-infected Kenyan women and their children living in rural households in the Nandi District
2) to determine if the Kenyan agricultural system has the potential to provide the ASF needed to maintain nutritional status, particularly to improve lean mass and immune function as well as provide food security for those families living with HIV and AIDS.

Proposed methodology:

- Objective 1: A nutrition intervention trial at one HIV and AIDS treatment clinic near Eldoret, Kenya will compare the health status of patients provided ASF with those who are not provided ASF; a meat-supplemented group will also be compared to a milk and egg supplemented group.
- Objective 2: Nutrient profiles of foods with the potential to improve health outcomes will be developed and constraints to increased production of those foods in Western Kenya will be identified.

This research is of interest to health professionals, agricultural research and extension personnel and policy makers worldwide. The initial research will be implemented by faculty and staff from three United States universities, two Kenyan universities and the Kenya Agricultural Research Institute (KARI), in collaboration with the Academic Model for Prevention and Treatment of HIV/AIDS (AMPATH) at Moi University, as well as Kenyan and international non-governmental organizations (NGOs). AMPATH is funded to provide care that includes highly active antiretroviral treatment (HAART) to 40,000 patients and is recognized by the Kenyan government as the lead training site for HIV care in Western Kenya. The lead principal investigator for the proposed research will be Carol Boushey, Department of Foods and Nutrition, Purdue University. Other United States universities involved are Indiana University and University of California, Los Angeles (UCLA). Kenyan involvement is from Moi University, Eldoret, and Egerton University, Njoro.

Research

Problem Statement and Approach. The Activities listed below resulted in the problem statement: HIV and AIDS have a profound effect on the human system and agricultural productivity and cause barriers to adequate nutrition. Even with appropriate medical care that includes antiretroviral drugs, persons living with HIV & AIDS (PLWHA) are more likely to develop AIDS and die when poverty and food insecurity prevail. Low agricultural productivity is a direct consequence of HIV and AIDS and results in nutritional deficiencies of energy, protein and micronutrients. Increased agricultural productivity will help to provide a reliable supply of a variety of foods in enough quantity that energy needs are met and protein intake is spared to support immune function and to maintain lean body mass. A variety of foods rich in micronutrients will be available inclusive of animal source foods for vitamin B12, bio-available iron and zinc and essential and conditionally essential amino acids. This increased availability of improved quality food, we hypothesize, will prevent or slow the progression of HIV disease. Impact can be measured from changes in immune status, lean body mass, HIV viral load, work productivity, quality of life and mortality.

Team Formation. We formulated a team of US researchers and met in person and via conference call in 2004 on October 6, November 23 and December 13 and in 2005 on January19, February 15, April 14, May 31, June 6 and June 9. We included input from senior researchers formerly funded by the GL-CRSP for nutrition projects in Kenya and discussions with AMPATH program faculty. We also discussed potential collaboration with members from the Bean/Cowpea CRSP and the Beans for Health Alliance who are studying the effect of various pulses on health with projects in Tanzania and Botswana.

Travel to Kenya. US researchers traveled to Kenya in November, 2004 and again in February/March, 2005 to investigate collaborative partnerships. A workshop was held in Eldoret, Kenya. US and Kenyan university faculty and professional staff in nutrition, agriculture and behavioral sciences participated. From these meetings and workshop, the following working hypotheses developed which guide the proposed research and intervention projects:

(1) Increased intake of ASF will improve treatment outcomes of HIV-infected Kenyan women, particularly if pregnant, and will improve the growth and overall health of their children through decreased infections, improved micronutrient and macronutrient intakes and status, and improved lean body mass. This hypothesis is supported in theory because ASF provide nutrients that are required for optimal immune status and for maintaining muscle mass; vitamin B12 and conjugated linoleic acid are only available through ASF. ASF provide essential amino acids as well as amino acids considered as conditionally essential in HIV disease. Meat provides the most bio available source of iron and zinc; two nutrients needed for maintaining immune function and lean body mass. Therefore results may show the greatest impact when meat is included.

(2) Redesigned rural farming systems will help meet the medical and nutritional objectives of HIV-infected smallholder farmers. This hypothesis is supported in theory because HIV-infected farmers may need to change what they produce and grow for family use to achieve nutritional objectives. HIV -infected farmers may not be able to work as hard as HIV negative farmers, and so they may need to consider labor saving technologies and/or lower labor crop and livestock alternatives. If a cooperative or out-grower scheme is organized to provide food for urban HIV patients, this may open economic opportunities for HIV-infected farmers.

Progress. During the assessment team phase, the project was able to:

- Develop collaborative relationships between US and Kenyan Universities.
  - -- A Memorandum of Understanding was drafted between Moi University and Purdue University that recognizes collaborative research and teaching endeavors.
  - -- Team formation with faculty from Egerton University, Indiana University, Purdue University, Moi University and University of California, Los Angeles.
- Develop collaborative relationships within US and Kenyan Universities.

-- Team formation with faculty from the Faculty of Health Sciences and Agriculture at Moi University.
-- Team formation with faculty from Nutrition and Agriculture at Purdue University.

- Generate a defendable research question and draft the 10 page "sell the concept" proposal.
- Identify project team members in Kenya needed to facilitate the research.
- Identify other sources of leveraged funding.

We were not able to draft a full proposal to be submitted for leveraged funding, but this is our intention.

Gender

The population to be studied is HIV-infected women of reproductive age in Kenya and their children. Women and girls make up a growing proportion of those infected by HIV and AIDS. At the end of 2004, UNAIDS reported that women made up almost half of the 37.2 million adults (aged 15-49) living with HIV and AIDS worldwide. The hardest-hit regions are areas where heterosexual contact is the primary mode of transmission. This is most evident in sub-Saharan Africa, where close to 60% of adults living with HIV and AIDS are women. Seventy-five percent of the agriculture workforce in Kenya is women.[6-9]

Gender related activities during the planning phase focused on information gathering and proposal development:

- Workshop: The workshop that was held in Eldoret, Kenya in March, 2005 that focused on HIV, Nutrition & Agriculture included women as well as men. Both in planning and in attendance. The planning and implementation of the workshop was a joint effort with both men and women in leadership roles. Eighteen (44%) of the forty-one persons attending the workshop were women. Five women gave presentations as part of the workshop; one in animal science nutrition, the other four in human nutrition.
- Visit to Nutribusiness: In Sotik, Bomet District, we visited a solar drying nutribusiness site run by women. This cooperative was developed by rural Kenyan women, Penn State University, Tuskegee University and the University of Nairobi and has been operational since 1992 and produced a variety of Nutri-Mix Porridge made from vegetables and grains. There were plans to also solar dry meat, which is why we visited. For the past year it has not been operational due to the death of one of the founders who gave key support to the enterprise. If the results of our study prove positive, this type of enterprise can be reproduced as part of a sustainability strategy - involving women in the development and implementation.
- During both trips to Kenya, November, 2004 and February/March, 2005, visits with faculty and staff in the Nutrition and Agriculture Departments of Egerton and Moi Universities included both men and women. Women predominated in nutrition and men in Agriculture, however one male nutrition faculty at Egerton is pursuing a doctorate and of the faculty in Agriculture at Moi University, two are women. All had the opportunity to participate equally in discussions about the proposed project.
- Team formation and information gathering included input from senior faculty and project manager, all women, previously funded by GL-CRSP for nutrition focused projects in Kenya.

Policy

No contributions were made to policy as a result of the planning phase. Potentially the study findings may contribute to national nutrition guidelines for persons living with HIV & AIDS. The proposed research was presented to policy makers in Nairobi at the GL-CRSP CNP meeting.

Meetings were held with the following individuals during this planning phase and the proposed project was discussed with them.

- Janet Paz-Castillo, Chief, USAID Mission in Kenya. Office of Population Health & Nutrition and Dr. David B. Elkins, PEPFAR

Coordinator, USAID Kenya. Ms. Paz-Castillo requested that a draft of our proposal be sent to her office for consideration for FY 2006 PEPFAR funding.

- Dr. Peter T. Ewell, Regional Ag. Advisor, USAID/REDSO/ESA/Food Security and Nzuki Solomon Mwania, Regional Trade Policy Specialist, USAID/REDSO/ESA/Food Security. Ewell said that he would like to be kept informed of the developments on the HIV, Nutrition and Agriculture Initiative. He suggested that our group contact the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), the Harvest + Initiative of the Consultative Group for International Agricultural Research (CGIAR) and Winrock.

Outreach

Given that this project is only in the planning phase, we have not accomplished any specific outreach activities other than the workshop held in Eldoret.

Developmental Impact

Environmental impact and relevance. The AMPATH program at this time addresses the nutritional needs of only 20% of patients who are the sickest and the most food insecure by giving them food. Body mass index (BMI) is calculated for all patients and is the only nutrition assessment measure used at this time. The proposed project incorporates more sensitive indicators of nutrition assessment and body composition that may be determined as critical measures to predict treatment response. AMPATH is recognized as the leader in training for health care provided to PLWHA in western Kenya. If determined to be useful, these nutrition assessment and health indicators could be implemented as part of the overall care and potentially improve management and health outcomes for a large number of patients in Kenya.

Agricultural sustainability. The proposed research identifies three agricultural activities to be implemented that will lay the foundation for understanding constraints to increasing cost effective production of ASF in Kenya:

1) determine nutrient profiles of ASF and other dietary staples linked to improved immune function,
2) describe current ASF production systems, including production calendars and enterprise budgets for nutritionally suitable foods,
3) identify the key constraints to increased production of ASF and
4) initiate on-farm demonstrations of ASF production technologies designed to address key constraints.

ASF production solutions identified by agriculture scientists will be tested on the AMPATH demonstration sites and on patient farms. Marketing options will be developed to allow urban HIV positive people access to the food and provide improved livelihoods for the farmers affected.

Contributions to U.S. agriculture. Two Purdue agriculture graduate students per year will travel to Kenya and assist in the development and demonstration of alternative ASF technologies on the AMPATH farms. They will learn from this international experience and share what they learned with their US colleagues.

Contributions to host country. Contribution of this proposed project within the country of Kenya include:

- Increased infrastructure within the academic departments of Moi and Egerton Universities that are involved in the research.
- Opportunities for academic training of Kenyan scientists.
- Opportunities for collaborative research for Kenyan faculty and staff from Moi and Egerton Universities, governmental and non-governmental organizations that are involved in the proposed project.
- More in-depth nutrition assessment of HIV-infected women and their children living in rural western Kenya. The results of this proposed research may provide basis for nutrition intake and assessment guidelines

for those living with or affected by HIV and AIDS, particularly in sub-Saharan Africa.
- Development of a strategy for sustainable production of ASF in rural Kenya.
- The findings of this project will be the first step in the formulation of a novel and replicable transportable HIV and AIDS nutrition and agriculture model for implementation in resource poor areas that includes guidelines and interventions that prevent and limit health deterioration and increase food security within families and communities.

Linkages and networking. Nutrition scientists will use the nutrient profiles of foods identified initially and focus on biochemical assessments of micronutrients (iron, zinc, selenium, vitamin B12, magnesium) and protein in HIV-infected women and their children in addition to indices of immune function as outcomes to the various nutrition interventions. The laboratory methodology, equipment and trained personnel costs for these analyses are beyond the capacity of the GL-CRSP funding and will require leveraged funding. Collaborators have been identified [Lindsay Allen (vitamin B12), UC Davis, Tom Hongo (selenium), Kenyatta University, Julia Otaya (zinc), Kenyatta University and David Mwaniki (iron), KEMRI]. David Mwaniki who is the Assistant Director, Kenya Medical Research Institute (KEMRI) and Director, Center for Public Health Research is interested in the design that we propose so that they can use a similar design with a study that will be initiated in a HIV-infected population that will use a multimix corn soy blend as a nutrition intervention. They are interested in our design so that we will be able to compare data. Grace Ettyang, Moi University will represent our proposed design at their upcoming project design meeting.

Dr. Barry Colley, Director, Enterprise Development and Global HIV Support for Heifer International is interested in receiving our proposal and participating at some point.

Thomas Fitz Randolph, PhD, Agricultural Economist for the International Livestock Research Institute (ILRI) is very interested in our proposed research and is developing a concept paper related to the importance of ASF in the diets of HIV-infected individuals. He will be forwarding the paper to us for review.

Collaboration with international research centers (IARCS) and other CRSPs. This project is building upon the knowledge gained from the GL-CRSP CNP related to the effect of ASF on lean body mass accretion in school-age children in Embu District, Kenya. Two senior researchers from the CNP are collaborators with this proposed project.

The research team will interface with staff at the Kenya Agriculture Research Institute (KARI) at the Naivasha Station for the analysis of key nutrients known to support and improve immune function from foods produced by local farmers and purchased at local markets.

This implementation plan is for an initial three-year "proof of concept" study. If the three year initial stage is successful, realization of overall project goals will require: verification of the value of meat in relation to milk/eggs and legumes in a broader population is planned and can involve collaboration with the Bean/Cowpea CRSP and the Beans for Health Alliance.

Other Contributions

Support for free markets and broad-based economic growth. Nothing related to support for free markets and broad-based economic growth has transpired at this early stage of the project, however contact was made with the solar drying Nutri Business enterprise in Sotik, Bomet District described in the gender section. Another like enterprise is located in Marengo, Kenya. They resulted from work led by Audrey Maretzki, Penn State University and with faculty from Tuskegee University and the University of Nairobi who trained local women to start and maintain a business that can also improve nutritional resources for families throughout the areas. The cooperatives, involving nearly 2,500 women, were established to manufacture and market locally produced, culturally appropriate, nutritious and affordable food mixes for toddlers, while the women shareholders gained new, socially suitable opportunities for self-employment and income generation. Additional information can

be found at: http://www.outreach.psu.edu/news/magazine/Vol_4.2/award.html. If we find from the proposed research that meat proves beneficial in the diets of HIV-infected women and their families, we will investigate collaborative efforts with these cooperatives as a strategy for dried meat production and sustainability.

Contributions to and compliance with mission objectives. One of the mission objectives of the USAID/Kenya's health program is to provide care and support for those already infected. Being a focus country within the President's Emergency Plan for AIDS Relief (PEPFAR) the country team is planning a major expansion of HIV/AIDS programs, with special attention to care and treatment. Nutrition assessment and food-based interventions that may impact HIV disease progression have not been applied to the problem in Kenya. Our proposed project will provide new information that may have wide application for treatment and care of PLWHA.

Another mission objective of USAID is to support several projects to identify and establish sustainable strategies to enable communities to cope with the needs of HIV-positive children and those orphaned by AIDS. Our project includes providing food to families and measuring the impact of ASF not only on the health of the HIV-infected women but also of one target child in the household. These children are viewed as vulnerable and our findings can be applied at the community level in the development of sustainable initiatives for children.

Another mission objective is to reduce the impact of infectious diseases; focused primarily on strategies to prevent malaria and TB. The underlying science that supports this research question relates to maintaining immune function. Thus the knowledge gained can be translated directly to the non HIV-infected population who live in environments that place them at high risk for contracting infectious diseases.

Concern for individuals. The project is focused to benefit the population at highest risk for HIV-infection in Kenya, women of reproductive age and their children. What is learned will be extrapolated to benefit other populations as well in Kenya and throughout areas with high HIV prevalence.

Support for democracy. The project is focused to benefit HIV-infected persons in Kenya and their families. This population suffers from stigma and food/nutrition insecurity. What is learned will be disseminated to policy makers in the local, national and international communities and sustainable strategies will be developed.

Humanitarian assistance. Currently, a significant percentage, (20-50%), of those infected with HIV in rural Kenya are food insecure. About 20% of patients enrolled in the AMPATH program receive food aid. The project that is proposed will initially focus on the impact of a food-based nutrition intervention for those individuals enrolled in the AMPATH program for HIV care, and however are not receiving any food aid from AMPATH. Study participants will be provided additional food for themselves and their families. It is currently unknown what the nutritional needs are for HIV-infected individuals.

Leveraged Funds and Linked Projects

We are planning to submit proposals for leveraged funding to the National Institute of Child Health and Human Development (NICHD), Robert Thrasher Foundation, Cattleman's Association, Heifer International and PEPFAR USAID Kenya Mission.

Training

Short term

Attended Kenya Coalition for Action in Nutrition (KCAN) Inaugural National Nutrition Congress (INNC) entitled Food and Nutrition Security for Health and Development (Feb 21-23, 2005) in Nairobi, Kenya

Attended the GL-CRSP Child Nutrition Project meeting with policy makers in Nairobi, Kenya. Made a short presentation related to the proposed HIV, Nutrition & Agriculture project in development.

Workshop in Eldoret – HIV, Nutrition &

Agriculture in Western Kenya. Led the 2 1/2 day workshop with ~ 40 faculty and professionals with expertise in nutrition, agriculture, education and social science from US and Kenyan universities, NGOs and governmental organizations participated.

Collaborating Personnel

United States

Todd Applegate, Ph.D., Dept. of Animal Sciences, Purdue University, poultry nutrition and management.

Carol Boushey, Ph. D., RD., Dept. of Foods and Nutrition, Purdue University, nutritional epidemiology and dietary assessment.

Shawn S. Donkin, Ph.D., Dept.of Animal Sciences, Purdue University, Expertise in dairy cattle nutrition and management.

Judith A. Ernst, DMSc, RD, Dept. of Nutrition and Dietetics, Indiana University, nutrition assessment as it relates to children and HIV infection.

Jess Lowenberg-DeBoer, PhD, Dept. of Ag Economics, Purdue University, economics of agricultural technology, including impact assessment

George McCabe, PhD, Dept. of Statistics, Purdue University

Suzanne Murphy, PhD, RD, University of Hawaii, diet analysis and nutrient data bases

Charlotte Neumann, MD, University of California Los Angeles, child development and cognitive assessment

John Sidle, MD, Indiana University (Pediatrician) Liaison to AMPATH

Tony Vyn, Ph.D., Department of Agronomy, Purdue University, USA. Expertise in cropping systems and nutrient availability.

Kara Wool-Koulstain, MD, Indiana University (Infectious Disease) Liaison to AMPATH

Kenya

David Ayuku, PhD. Clinical Psychologist, Dept. of Behavioral Sciences, Moi University, nutrition in relation to child development and cognitive assessment

Grace Keverenge-Ettyang, PhD, Dept. of Epidemiology and Nutrition, School of Public Health, Moi University, maternal micronutrient malnutrition and body composition assessment

Abdi Yakub Guliye, PhD., Dept. of Animal Science, Egerton University, ruminant nutrition and management

John Kariuki, PhD., National Animal Husbandry Research Center, animal nutrition

Solome Korir, MSc., Dept. of Epidemiology and Nutrition, School of Public Health, Human Nutrition, Moi University, food security, dietary intake, maternal and child nutrition

Peninah Masibo, MPH, (Human Nutrition) Dept. of Epidemiology and Nutrition, School of Public Health, Moi University, maternal and young children nutritional status and dietary intake

Patrick W. Mathenge, PhD., Dept. of Crop Science and Seed Technology, Moi University, crop physiology

Margaret Ngigi, PhD., Dept. of Agricultural Economics, Egerton University, agricultural marketing and agricultural policy

Winstone Nyandiko, MD, Pediatrician, Dept. of Child Health & Pediatrics, Moi University, mother to child transmission (MTCT) of HIV and pediatric HIV care specialist

Caleb O. Othieno, PhD. Dept. of Soil Science, Moi University, soil scientist

Joseph Rotich, Moi University, statistician

Abraham Siika, MD, Department of Medicine, Moi University, adult medicine.

Ann Wachira, PhD., Kenya Agriculture Research Institute, Naivasha, animal nutrition

Collaborating Institutions

United States

Indiana University
School of Health & Rehabilitation Sciences
Coleman Hall 224
1140 West Michigan Street
Indianapolis, Indiana 46202-5119
Ph. 317-274-9901
Fax. 317-278-3940

School of Medicine
IU-Kenya Partnership
1001 W. 10th Street, M200
Indianapolis, IN 46202
Ph: 317.630.8695
Fax: 317.630.7066

Purdue University
International Programs in Agriculture
615 W. State Street
Agriculture Administration, Room 26
West Lafayette, IN 47907-2053
Ph. 765-494-8461
Fax: 765-494-9613

Consumer & Family Sciences
700 W State Street, Room 202
West Lafayette, IN 47907-2059
Ph: 765-496-6569
Fax: 765-494-0674

University of California, Los Angeles (UCLA)
Community Health Sciences & Pediatrics
School of Public Health and School of Medicine
650 Charles Young Dr.
Los Angeles, CA 90895
Ph: 310-825-2051

Kenya

Moi University
Dept.of Epidemiology and Nutrition, School of Public Health
PO Box 4606
Eldoret, Kenya
Ph: 254-722-609-257

Egerton University
Department of Animal Science
PO Box 536
Njoro, Kenya
254-722-800-242

Kenya Agriculture Research Institute (KARI)
PO Box 25
Naivasha, Kenya
Ph: 254-722-443-973

Abstracts and Presentations

Ernst, JA - presented briefly proposed idea: "Increasing Animal Source Foods in Diets of HIV-infected Kenyan Women and Their Children: Can Treatment Outcomes be Enhanced?" at the GL-CRSP CNP meeting with policy makers, February 28, 2005, Nairobi, Kenya.

Ernst, JA - presented proposal: "Increasing Animal Source Foods in Diets of HIV-infected Kenyan Women and Their Children: Can Treatment Outcomes be Enhanced?" at the GL-CRSP biennial meeting, June 24, 2005, Dublin, Ireland.

Footnotes and References

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Lead Principal Investigator

Judith A. Ernst, DMSc, RD, Dept. of Nutrition and Dietetics, Indiana University, School of Health and Rehabilitation Sciences, Indianapolis, IN 46202. Phone: (317) 274-9901; Fax: (317) 278-3940. Email: jernst@iupui.edu.

Glossary

A-AARNET	ASARECA Animal Agriculture Research Network
ACDI	Agricultural Cooperative Development International
ADB	African Development Bank
ADRA	Adventist Development and Relief Agency Canada
AFD	Action for Development
AGWA	Automated Geospatial Watershed Assessment
ALIN	Arid Lands Information Network
AID	Agency for International Development, Washington D.C., USA
AIDS	Acquired Immune Deficiency Syndrome
ALRMP	Arid Lands Resource Management Project
AMPATH	Academic Model for Preventiona nd Treatment of HIV/AIDS
AMREF	African Medical Research Foundation
AR	Action Research
ASAL	Arid and Semi-Arid Land
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ASCE	American Society of Civil Engineers
ASF	Animal Source Foods
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
ASTM	American Society for Testing and Materials
ATIRI	Agricultural Technology and Information Response Initiative
AU/IBAR	African Union/Inter-African Bureau for Animal Resources
BASIS CRSP	Broadening Access and Strengthening Market Input Systems Collaborative Research Support Program
BLPDP	Borana Lowlands Pastoral Development Project
BIOMAP	Biological Monitoring and Assessment Program
BIOMAT	Biological Monitoring and Assessment Tool
BLM	Bureau of Land Management, United States
CAP	Community Action Plan

CARE	Cooperative for American Remittance to Europe, Inc.
CBO	Community-based organization
CGIAR	Consultative Group for International Agricultural Research
CHPS	Community Health Promotion Service
CIDA	Canadian International Development Agency
CIFA	Community Initiatives Facilitation and Assistance
CMO	Crisis Mitigation Office
CMORPH	Climate Prediction Center Morphing Method
CNP	Child Nutrition Project, GL-CRSP
CRSP	Collaborative Research Support Program
DEM	Digital Elevation Model
DFID	Department for International Development, United Kingdom
DLPO	District Livestock Production Officer
DO	Dissolved Oxygen
DOM	Digestible Organic Matter
DPPC	Drought Preparedness and Prevention Commission
DPPB	Disaster Preparedness Planning Board
EARO	Ethiopian Agricultural Research Organization
E/K	Ethiopia/Kenya
EMC	Environmental Management Committee
ENAM	Enhancing child Nutrition through Animal source food Management
EPD	Ethiopian Pastoralist Day
EROS	Earth Resources Observation System
FAO	Food and Agriculture Organization, United Nations
FAO FSAU	Food and Agriculture Organization Food Security Assessment Unit
FCI	Forage Condition Index
FERD	Faculty of Environmental Science and Resource Development, or FESNARE
	Famine Early Warning System Network
FHI	Food for the Hungry International
GHA	Greater Horn of Africa
GHS	Ghana Health Services
GIS	Geographic Information System

GL-CRSP	Global Livestock Collaborative Research Support Program
GSME	Greater Serengeti-Mara Ecosystem
GO	Government Organization
GOK	Government of Kenya
GPS	Global Positioning Systems
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit (German Agency for Technical Cooperation)
GYE	Greater Yellowstone Ecosystem
ha	Hectare
HAART	Highly Active Antiretroviral Treatment
HQ	Headquarters
ICPAC	IGAD Climate Prediction and Applications Centre
ICAB	Institute for Countermeasures Against Agricultural Bioterrorism
ICT	Information and Communication Technology
IEHA	Initiative to End Hunger in Africa
IGA	Income Generating Activity
IGAD	Intergovernmental Authority on Development
IGC	Intergovernmental Conference (EU)
ILRI	International Livestock Research Institute
INCAP	Instituto de Nutricion de Centro America y Panema
IPAL	Integrated Project for Arid Lands
ISU	Iowa State University
IWMI	International Water Management Institute
IWTO	International Wool Textile Organization
JSS	Junior Secondary School
KACE	Kenya Agricultural Commodity Exchange
KARI	Kenya Agricultural Research Institute
KDA	Kenya Rural Enterprise Program Development Agency
KEMRI	Kenya Medical Research Institute
KLMC	Kenya Livestock Marketing Council
KLTA	Kenya Livestock Traders Association
kg	Kilogram
KMD	Kenya Meteorological Department

KPPG	Kenya Pastoral Parliamentary Group
KSBA	Kyrgyz Sheep Breeders' Association
Ksh	Kenya Shilling (also **KES**)
LEWS	Livestock Early Warning System
LiTEK	Livestock Marketing in Kenya and Ethiopia Project, GL-CRSP
LINKS	Livestock Information Network and Knowledge System Project, GL-CRSP
LMIS	Livestock Market Information System
LULCC	Land Use and Land Cover Change
MASHAV	Hebrew acronym for Center for International Cooperation
MDP	Marsabit Development Program
ME	Management Entity
MET	Meteorology
MoARD	Ministry of Agriculture and Rural Development
MOFA	Ministry of Food and Agriculture, Ghana
MoLFD	Ministry of Livestock and Fisheries Development
MOU	Memoradum of Understanding (also **MoU**)
NAFTA	North American Free Trade Agreement
NALRC	National Arid Lands Research Center
NARC	Natural Agricultural Research Council
NARO	National Agricultural Research Organization
NASA	National Aeronautics and Space Administration
NDVI	Normalized Difference Vegetation Index
NGO	Non-Government Organization
NIRS	Near Infrared Reflectance Spectroscopy
NH4-N	Ammonium Nitrogen
NHANES	National Health and Nutrition Education Survey
NICHD	National Institute of Child Health and Human Development
NOAA RFE	National Oceanographic and Atmospheric Administration Rainfall Estimate
NRCS	National Resources Conservation Service (USDA)
NSF	National Science Foundation, United States
NUTBAL	Nutritional Balance Analyzer
OADB	Oromia Agricultural Development Bureau

OARI	Oromia Agricultural Research Institute
OCPB	Oromia Cooperative Promotion Bureau
OFDA	Office of Foreign Disaster Assistance, USAID (LINKS project)
OFDA	Optical-based Fiber Diameter Analyser (used by WOOL Project)
OPDC	Oromia Pastoral Development Commision
PAHO	Pan American Health Organization
PARIMA	Pastoral Risk Management Project (GL-CRSP)
PEPFAR	President's Emergency Plan for AIDS Relief
PHYGROW	Plant Growth/Hydrology/Yield Simulation Models
PI	Principal Investigator
PLI-EW	Pastoral Livelihoods Initiative - Early Warning
PLMMO	Pastoral Livestock Movement Model
PLWHA	Persons Living With HIV/AIDS
PRA	Participatory Rural Appraisal
RANET	Radio and Internet
RAP	Research Activity Plan
RATIN	Regional Agricultural Trade Intelligence Network
RCMRD	Regional Center for Mapping of Resources for Development
RECONCILE	Resource Conflict Institute
REDSO	Regional Economic Development Services Office for East and Southern Africa (USAID)
RFQ	Request for Qualifications
RIING	Research to Improve Infant Nutrition and Growth
RUSLE	Revised Universal Soil Loss Equation
SCF - UK	Save the Children Fund - United Kingdom
SCF - USA	Save the Children Fund - United States
S/K	Somalia/Kenya
SMS	Short Message Service
SNV	Netherlands Development Organization
STI	Southern Tier Initiative
SUMAWA	Sustainable Management of Watersheds: the River Njoro, Kenya (GL-CRSP)
SWAT	Soil and Water Assessment Tool
TARDA	Tana and Athi Rivers Development Authority

TAMU	Texas A&M University
TBA	Traditional Birth Attendants
TN	Total Nitrogen
TP	Total Phosphorous
UCD	University California, Davis
UCLA	University of California, Los Angeles
UG	University of Ghana
UK	United Kingdom
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNEP	United Nations Environamental Program
UNESCO	United Nationas Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
USD	United States Dollar
USDA ARS	United States Department of Agriculture Agricultural Research Service
US-EPA	United States Environmental Protection Agency
USFS	United States Forest Service
USGS	United States Geological Survey
USU	Utah State University
UT	Utah
VCI	Vegetation Condition Index
VIP	Village Infrastructure Project
VOCA	Volunteers in Overseas Cooperative Action
VSF	Veterinaires Sans Frontiers - Suisse
WB	World Bank
WEAP	Water Evaluation And Planning System
WFP	World Food Program
WHO	World Health Organization
WID	Women in Development
WTO	World Trade Organization
YESEMA	Yellowstone-Serengeti-Mara Project, GL-CRSP
YNP	Yellowstone National Park